MARCH 1953

Journal

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AMERICAN WATER WORKS ASSOCIATION

In this issue

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AMERICAN WATER WORKS ASSOCIATION

March 1953

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Contents

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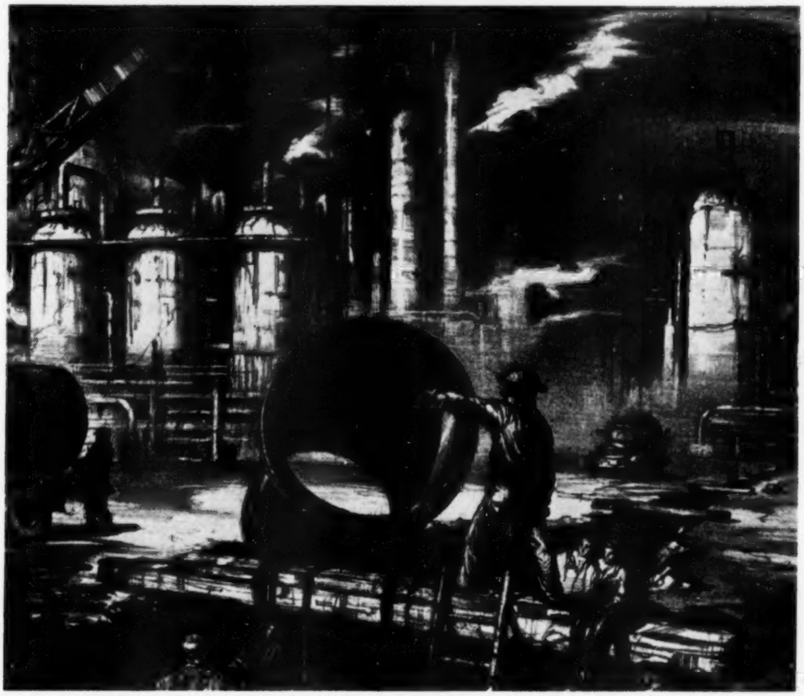

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Coming Meetings

AWWA SECTIONS

Mar. 18–20—Illinois Section at La-Salle Hotel, Chicago. Secretary, J. Leslie Hart, Western Sales Manager, U.S. Pipe & Foundry Co., 122 S. Michigan Ave., Chicago 3, Ill.

Mar. 19—New England Section at Continental Hotel, Cambridge, Mass. Secretary, George G. Bogren, Partner, Weston & Sampson, 14 Beacon St., Boston 8, Mass.

Mar. 23–25—Southeastern Section at Dempsey Hotel, Macon, Ga. Secretary, T. A. Kolb, 89 Alexander St., Charleston, S.C.

Apr. 6–8—Canadian Section at Statler Hotel, Buffalo, N.Y. Secretary, A. E. Berry, Director, Ontario Dept. of Health, Parliament Bldgs., Toronto 8, Ont.

Apr. 16–17—Nebraska Section at Cornhusker Hotel, Lincoln. Secretary, E. Bruce Meier, Asst. Prof. of Civ. Eng., Univ. of Nebraska, Lincoln, Neb.

Apr. 16–17—New York Section at Mark Twain Hotel, Elmira. Secretary, R. K. Blanchard, Vice-Pres. & Engr., Neptune Meter Co., 50 W. 50th St., New York 20, N.Y.

Apr. 16–18—Pacific Northwest Section at Multnomah Hotel, Portland, Ore. Secretary, O. P. Newman, Exec. Vice-Pres., Boise Water Corp., Boise, Idaho.

Apr. 16–18—Arizona Section at San Marcos Hotel, Chandler. Secretary, M. V. Ellis, Supervisor, Sewage Treatment Plant, Phoenix, Ariz.

Apr. 22–24—Kansas Section at Broadview Hotel, Wichita. Secretary, Harry W. Badley, Repr., Neptune Meter Co., 119 W. Cloud, Salina, Kan.

AWWA ANNUAL CONFERENCE

Grand Rapids, Mich. May 10–15, 1953

All reservations will be cleared through the AWWA office. The hotels have agreed to accept no reservations for the 1953 Conference except as they are requested on the standard form, through the AWWA.

(Continued on page 10)

Coming Meetings

(Continued from page 8)

Apr. 24–25—Montana Section at Kalispell Hotel, Kalispell. Secretary, Arthur W. Clarkson, Asst. Director, Div. of San. Eng., State Board of Health, Helena, Mont.

June 10—New Jersey Section Summer Outing and Inspection of Johns-Manville Research Center, Finderne. Luncheon at Martinsville Inn, Martinsville. Secretary, C. B. Tygert, Wallace & Tiernan Co., Inc., Box 178, Newark 1, N.J.

June 17–19—Pennsylvania Section at Hershey Hotel, Hershey. Secretary, L. S. Morgan, Div. Engr., State Dept. of Health, Greensburg, Pa.

OTHER ORGANIZATIONS

Mar. 16–20—National Assn. of Corrosion Engineers at Hotel Sherman, Chicago, Ill. Details from A. B. Campbell, Executive Secy., 1061 M & M Bldg., Houston 2, Tex.

Mar. 18–20—Short course for water and sewerage personnel at Louisiana State Univ., Baton Rouge. Details from John H. O'Neill, Director, Div. of Public Health Eng., State Dept. of Health, Civil Courts Bldg., New Orleans 7, La.

Mar. 23–27—Western Metal Exposition and Congress, Statler Hotel, Los Angeles, Calif. Details from William H. Eisenman, Secy., American Society for Metals, 7619 Beverly Blvd., Los Angeles, Calif.

Mar. 24–25—National Public Health Engineering Conference at Gainesville, Fla. Details from John E. Kiker Jr., 210 Engineering & Industries Bldg., Univ. of Florida, Gainesville, Fla.

Apr. 6–30—Lectures on prestressed concrete, Monday and Thursday evenings at Newark College of Engineering, 367 High St., Newark 2, N.J. Details from Special Courses Div.

Apr. 20–21—Industrial waste disposal regional conference at New Orleans, La. Details from H. M. Conway Jr., Director, Southern Assn. of Science & Industry, 5009 Peachtree Rd., Atlanta, Ga.

Apr. 24—Ohio certification exams for water and sewage plant operators. Details from J. E. Richards, Secy., Advisory Board of Examiners, 306 Ohio Departments Bldg., Columbus 15, Ohio. Applications must be filed at once.

May 4–6—Purdue Industrial Waste Conference at Purdue Memorial Union Bldg., Lafayette, Ind. Reservations from Purdue Union Club, Fowler Hotel, Cedar Crest Hotel, or Morris Bryant Hotel. Details from Don E. Bloodgood, Civil Engineering Bldg., Purdue Univ., Lafayette, Ind.

June 16–19—Spring Technical Meeting and Welding Exposition of American Welding Society at Shamrock Hotel, Houston, Tex. Details from Society at 12 E. 41st St., New York 17, N.Y.


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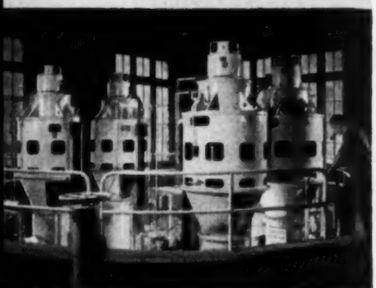

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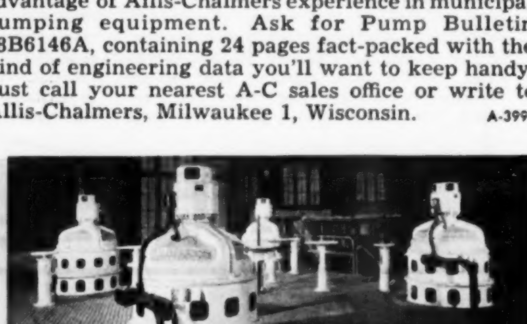

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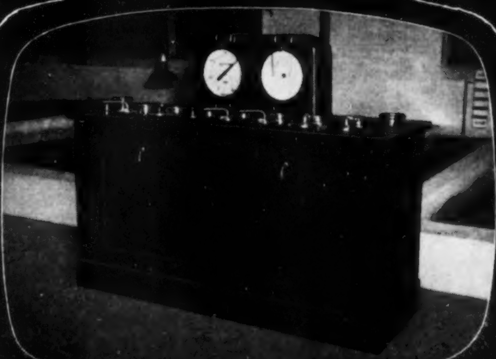

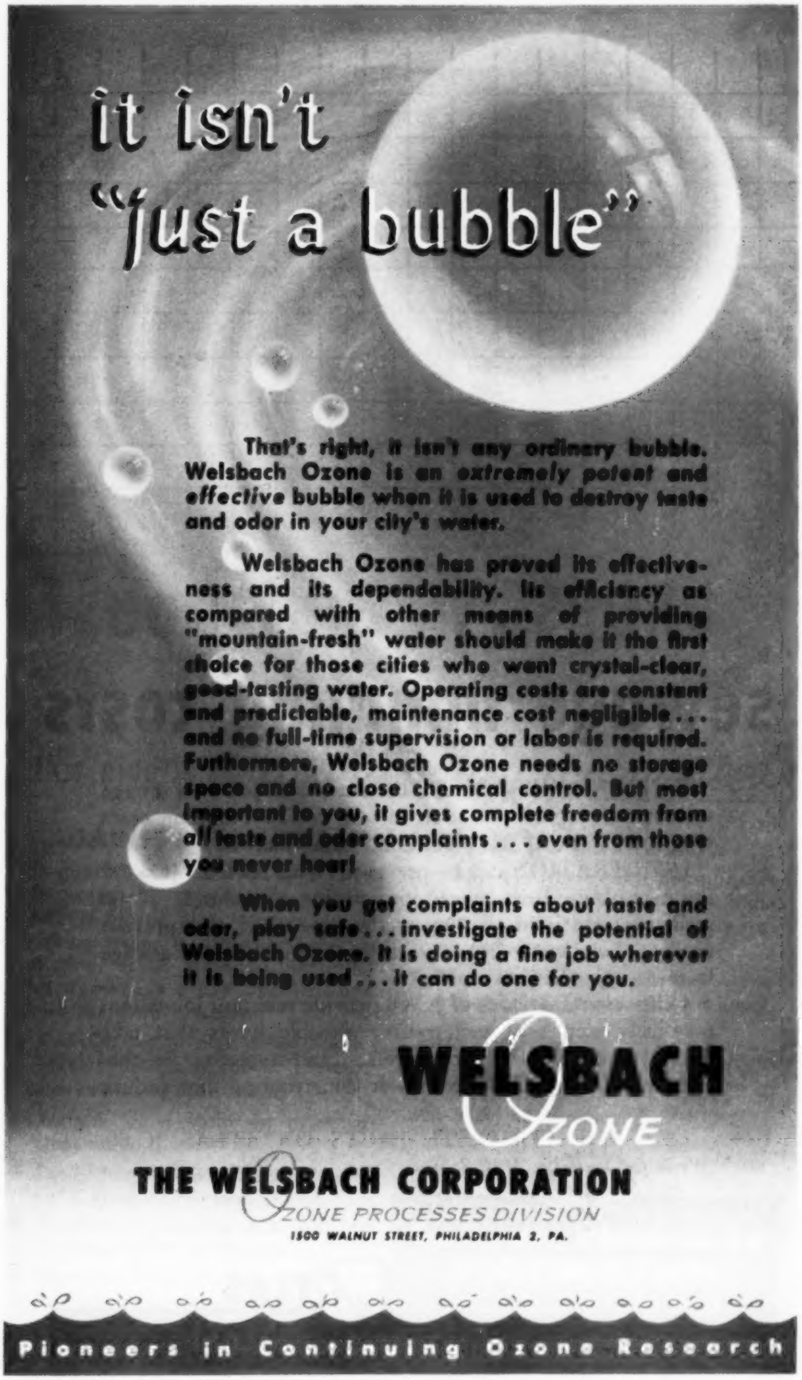
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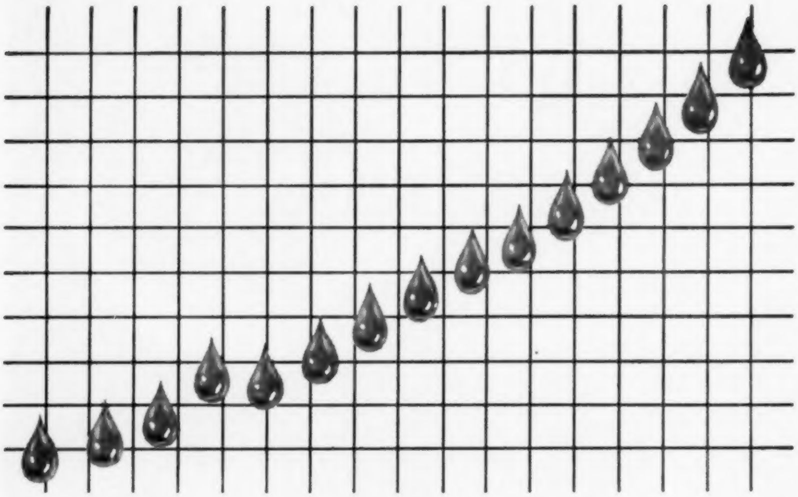

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Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 45 • MARCH 1953 • NO. 3

Current Water Works Headaches

By Ernest D. Hawkins

A paper presented on Sept. 16, 1952, at the Kentucky-Tennessee Section Meeting, Knoxville, Tenn., by Ernest D. Hawkins, Engr., Water Eng. Dept., Knoxville Utilities Board, Knoxville, Tenn.

THE operation of a water utility, even when resources, equipment, and personnel are adequate, always presents certain difficulties, both expected and unforeseen, which must be reckoned with daily. Among these are many small nuisance items which cause headaches to the operator and to management as well.

Before discussing these minor troubles, it seems appropriate to outline briefly some of the more vital problems which have beset water works management in recent years.

Postwar Problems

During the prewar period most water utilities were able to keep pace with their normal expansion requirements. Their labor forces and supervisory personnel were fairly well stabilized. Their rate structures were usually sufficient to yield enough revenue for operation, normal expansion, and bond retirement. During the war there was a manpower shortage in all industries, water utilities not excepted. Labor forces were always inadequate, and there was a rapid turnover in those available. Only key supervisory personnel remained intact, and sometimes even these were not spared. This rapid turnover of personnel was anything but conducive to the future welfare of the organization. There was also a materials shortage, which led to a program of material allotments, regulations, and substitutes. In many areas, water works men were faced with greater demands for water service than ever before, but all construction or expansion had to be postponed if possible. Consequently, the end of the war found most water systems actually behind in their work on normal maintenance, construction, and major plant facilities.

Added to this backlog are the new demands due to the postwar residential construction. Many new residential areas were annexed to cities and towns, creating new problems of dis-

tribution and supply. Distribution systems had to be reinforced, and usually additional supply and treatment facilities had to be provided. Most water works have been able to meet this situation successfully, but not without their share of headaches.

The outbreak of the Korean hostilities again caused a necessary restriction in the use of certain critical materials. Delivery of some types of materials has been slow and uncertain, even with the necessary government approval and allotments. For example, some kinds of pipe fittings require 120 days for delivery, while steel tanks and standpipes take 12–15 months. Certain other critical materials are restricted and allocated according to a priority system. Items which formerly were delivered from factory or distributor stocks on order must now be ordered several months in advance of the desired delivery date. This condition alone presents numerous problems to a person planning a job, especially an urgent one.

Manpower seems to be adequate for most types of work today, but the semiskilled and skilled labor force is still not completely stabilized. The competition of large defense projects for skilled workmen is a factor to be considered.

The buying power of the dollar has reached the lowest ebb in memory. A great many water works managers are faced with the necessity of raising the funds for operation and construction at current prices although their rate schedules are based on costs of a decade or so ago. This fact alone is the root of a thousand difficulties.

A successful engineering endeavor requires the proper application and use of men, materials, and money. The problems due to existing deficiencies in each of these fundamental items are greatly compounded by the abnormal, though necessary, expansion of plant facilities in recent years.

Relocation of Facilities

Recent years have seen a trend toward radical and extensive improvement of state and federal highway systems in urban areas. Although highway and expressway projects with their cloverleaf intersections are a welcome symbol of progress, they present large problems to the water works man. The general policy all over the country has been to force water utilities to relocate and adjust their facilities at their own expense, without any aid from the state or federal government which sponsors the highway improvements. Water works men universally agree that this policy is unjust and believe that the sponsors of such improvements should share the expenses incurred in relocation. It is hoped that some definite action will be taken by Congress, as well as by state legislative bodies, to make such grants possible.

Frequently construction of these highway improvements has caused the water utility extreme hardship other than financial. The work involved in relocation may have to be performed over a short period and in close coordination with the highway construction. This has presented a multitude of problems which should be apparent to anyone familiar with water works construction. Although management has suffered its share of headaches, the operators also have been presented with new and varied problems in addition to older and ever-present troubles.

Seasonal Demands

The advent of air conditioning, especially for comfort cooling, at larger

installations has placed an additional load on water systems during the summer months, a time when most systems are already operating at their maximum output. A study of air-conditioning loads will show that this problem was not significant ten or fifteen years ago, but today it is the rule rather than the exception to find air conditioning installed in commercial establishments, hotels, office buildings, and large industrial plants. The use of evaporative condensers at the installation is helping to decrease this demand in areas of cheap electric power. Where such power is expensive and water is cheap, however, the air conditioners installed are likely to be of the type requiring a constant supply of running water.

Another seasonal-demand problem is the multiple-spray connection for lawns and gardens. Multiple sprayers are a relatively new item in Tennessee, and Knoxville was particularly fortunate in that only two of these units were connected to the system during 1952. Both were located in a section where adequate pressure and volume could be obtained at all times. If these lawn spray systems had been connected in some other outlying section, however, they would probably have given considerable trouble because of the nature of their demand.

Still another source of seasonal demand which may sometimes cause difficulties is the swimming pool. Normally served by a large connection and usually situated at the remote end of the system, the pool is always refilled at a time most convenient to the operator, usually the driest Mondays following the summer holidays.

Cross-Connections

Cross- and interconnections are a chronic headache. Regular inspections are absolutely necessary to eliminate this health hazard. These routine inspections usually reveal new connections made by unauthorized or uninformed workmen, often without the knowledge of the proprietor or plant owner. Most property owners or plant managers are quite willing and cooperative in their efforts to help eliminate such connections, but they depend chiefly upon the water works man to point them out. Periodically the connections will show up in industrial plants, hotels, and commercial establishments.

Street Repairs

The repair of street surfaces where the pavement has been cut is a troublesome matter, regardless of whether the water works is privately or publicly owned or whether the street repairs are contracted for or performed by the water works forces. Practically all distribution facilities are undergound, usually in paved streets where repairs or alterations require the street surface to be cut. Even with the closest possible coordination between the crew that cuts the street and the one that repairs it, there is a traffic hazard involved, with its accompanying liability. Restoring the street surface to its previous standard is difficult, and it is often necessary to cut back larger areas to achieve this result. Barricades, red lights, and work signs afford little protection against the reckless or careless driver. Good public relations often requires the installation of temporary patches when the work cannot be completed immediately. These are an additional expense, as they must be removed when the permanent repairs are made. There is a movement in one city to impose a fee or penalty on the utility for every pavement-cutting operation, whether the utility

concerned has its own street repair facilities or not.

Sanitary and storm sewer construction or changes invariably require the adjustment of mains, hydrants, or services already installed.

Many homebuilders appear inclined to wait until long after their water service has been installed to have the final grading work performed on their yard. Property owners constantly request services and meters to be raised or lowered. In cities where it is the policy of the water department to maintain the service to the property line, these demands may involve relaying the entire service or resetting the meter.

Fire Hydrants

The subject of fire hydrants should not pass without mention. It seems that everyone wants fire protection, but nobody wants a fire hydrant located in front of his property. People who build on the property after a hydrant is already installed always want their driveway centered on the hydrant installation, or else the architect simply cannot design the building entrance any other way. Hydrants suffer from a multitude of determined enemies, and their only steadfast friend appears to be the dog. They are the favorite target of vandals. A hydrant wrench in the hands of a group of youngsters on Halloween can do more damage than a hungry wolf in a lamb fold. The department paints hydrants a bright color to identify them and help firemen see them readily after dark. Several methods of concealing hydrants are used by persons who object to this contrast with the natural color of the foliage in their yards. Some families plant hedges or set out shrubbery around the hydrants and then complain when the inspectors remove this growth. A few homeowners merely repaint the hydrant in a color of their choice.

By far the greatest enemy of the fire hydrant is the automobile driver. It sometimes seems that people drive to Knoxville from distant cities just to hit one of the local hydrants. Laws requiring public-liability insurance adequately cover damage to fire hydrants by automobiles, but such accidents are unpleasant for everyone concerned. Occasionally the guilty party will flee the scene of the accident, making it difficult or impossible to establish a claim against him.

Consumer Complaints

There is a vast array of small items which take up time and patience. Some of these troubles can be solved immediately, even over the telephone, but others are enough to perplex a scientist. The normal run of complaints includes: [1] noise in pipes; [2] failure of water-using appliances such as washing machines, dishwashers, or garbage disposal units (if it is connected to the water supply, call the water department first); [3] air in the water; [4] "poison chemicals" in the water; [5] too much pressure; [6] not enough pressure; [7] high water bills (complaints about low water bills are extremely rare); [8] inability to operate the property cutoff valve; and [9] presence of leaks.

There are many such complaints which the average water works operator considers routine. Most of these calls must receive some degree of attention, if only to maintain good public relations. During one sudden and severe cold spell the Knoxville Water Bureau handled 482 turnoff calls in one 24-hour period. One recent call came from a woman who was almost

frantic because her cat was trapped behind the hot-water heater.

Other Problems

Requests for temporary water service require an expenditure of labor and materials out of proportion to the amount of revenue expected. Numerous customers insist on immediate installation of service, forgetting that it is not always easy to depart from an established schedule to accommodate such requests. Some customers attempt to satisfy their water requirements with services that are too small or with piping choked by corrosion. A number of modern household appliances and fixtures, including flushometer toilet valves, require that a fairly high residual pressure be maintained if they are to function properly. The customer will usually install these items without consulting the water bureau, but, when difficulties arise, will expect the bureau to correct the situation at once.

During the severe drought in the summer of 1952 a few cities and towns whose supply comes from small streams, springs, or wells were forced to ration the use of water. Other cities with supplies that were inadequate but not in so critical a condition requested consumers to practice conservation. These months were not only among the driest on record but also the hottest, so that a dwindling source of supply was combined with an enormously increased demand. Most water systems in Tennessee experienced unprecedented load demands. Even those systems which had a dependable and ample source of supply were not without difficulties.

During periods of heavy draft some water customers in certain areas complained of low or inadequate pressure. On one occasion an excited customer telephoned to complain that there was no pressure at all and wanted to know why. The harassed water bureau employee, who had been receiving a steady flow of similar complaints from residents in that area, replied calmly and without facetious intent, "Mister, you just haven't got any water." Not a routine explanation, perhaps, but fundamental in its truth.

One of the greatest current headaches for the majority of water works operators is maintaining continuity of service to large newly built-up areas lacking adequate transmission, distribution, or storage facilities. Although existing distribution mains have been rapidly extended to such areas to meet postwar housing demands, many sections have grown beyond expectation. Consequently, water consumers whose services are located at the extremities of these extended mains or at an elevation near the normal hydraulic gradient are radically affected during periods of heavy draft on the system. Any weakness of a physical factor in the system, whether in the source of supply or in the distribution system, is immediately felt by such consumers. These critical areas sooner or later develop in every system, and the immediate solution to their water troubles is often impractical from a long-range viewpoint.

Only a few of the normal or routine tasks of operating a water system have been mentioned. Developing a source of safe, potable water and delivering it to the place where it is to be used is quite a task. For those who share the headaches and responsibilities involved in carrying it out, there is some compensation in the knowledge that a vital public service is being performed.

Organization of Suburban Areas

By Jackson T. Ramsaur and William N. Long

A paper presented on Nov. 11, 1952, at the North Carolina Section Meeting, Hendersonville, N.C., by Jackson T. Ramsaur, Health Officer, and William N. Long, Chief San. Engr., both of Gaston County Health Dept., Gastonia, N.C.

THE growth of American cities and towns within the past 20 years has been a subject of considerable interest to sociologists, municipal planners, city managers, city governments, and operators of municipal facilities. There is, however, another area of growth that warrants even closer scrutiny in the study of human population trends and living patterns. Although cities and towns are growing rapidly, the fringe areas immediately adjacent to their corporate limits, but outside them, are increasing in size and density even more rapidly. The relative rate of increase is in favor of the fringe area in spite of the reductions made in it by annexations to city and town.

Although cities and towns grow by annexing fringe areas, the fringe areas do not, conversely, annex city limits but, instead, extend farther into the rural land. The city grows by absorbing the fringe. The fringe grows by extending into the rural. There are created, then, three distinct bands of habitation: the urban, the fringe, and the rural. The U.S. Census Bureau arbitrarily includes some of the fringe in its classification of urban population and designates the remainder as rural, which serves effectively to ignore the existence of the fringe area as an entity and contributes nothing toward solving the special problems associated with the fringe.

The reasons for the development of fringe areas are fairly obvious. Present highways, telephones, and electric-power distribution make it unnecessary for a prospective homeowner to pay a high price for a city lot on which to build a cramped and crowded dwelling with little or no land in front or behind, to say nothing of the view from his side windows and the noise from the street. Searching for a suitable home site, he finds a pleasant, quiet glade outside the city limits and buys a piece of it for the view, the trees, and the space, openly rejoicing at his avoidance of city taxes, crowding, noise, and the cost of city land. In many ways he has a bargain. He is close to his work; his children ride to school on a free bus; he can have a garden; and, with electric and telephone service, he apparently enjoys all the advantages of the city with none of its disadvantages. Often a water line runs along the road in front of his house, saving him the cost and risk of digging a well, and the county health department helps him install a septic tank to dispose of his sewage. He is protected from thieves by the county police, and his house has not caught fire yet, so he does not feel the need for much, or any, fire insurance.

It takes several years for the fringe dweller to become fully aware of the disadvantage of living outside a mu-

nicipal area. Gradually he learns that space and economy and freedom are not the only components of happy, healthful living. He becomes aware of impending threats to his conception of a pleasant environment. The water pressure drops to zero, or less, during peak hours. His septic tank runs over. His neighbor lets garbage accumulate. His backyard becomes a lake in wet weather. There are flies all over the place, bred in adjacent cow pastures. Somebody builds a fertilizer factory to the windward. Cars and trucks race by his house at high speeds, threatening the lives of his children and raising clouds of dust. Mad dogs are a frequent menace. Jerry-built houses are beginning to cut off his view and his breeze. Now there is no place for his children to play but in the dusty street.

The suburban homeowner slowly becomes aware of the total lack of regulation in his community, and there seems to be little that he, as an individual, can do about it. His cow-owning neighbor moved there so that he *could* own a cow. The fertilizer factory is legally established. The owner of the water line does not care to correct its deficiencies. The homeowner himself is faced with the prospect of moving his sewage absorption field, but he has no land to which to move it. There is no minimum-lot regulation. His neighbors just let their septic tanks run over. Nobody collects garbage. Most of it is burned in makeshift incinerators, creating evil smells and fire hazards.

The fringe dweller finds that this uncontrolled, unregulated neighborhood is getting out of hand and is no longer pleasant to live in. Finally he decides to do something about his environment, and his first thought is the very government he had sought to avoid. But the county government has no power of regulation—only the power of taxation. It can control surface sewage pollution, but cannot construct health facilities, such as water plants and sewers. He turns to the city government, where he receives a cool reception. He and his neighbors have created an unwholesome and substandard place to live. The city can correct the situation only if the entire area is annexed and becomes a part of the city. This would be a most expensive procedure, because every part of that community is substandard. The houses, the streets, the water lines, the sewers and drainage facilities, if any—in fact, the entire physical structure—must be almost completely replaced with standard equipment. The capital outlay would require a long time to be amortized. The city does not want that neighborhood.

Eventually, of course, the problems of the unfortunate fringe dweller are solved at least partially by the annexation of his neighborhood to the city. This is done, not so much as a favor to him, but because his paradise has become a menace to the health of the people within the city. It is an act of self-defense on the part of the city.

At the same time, two or three miles farther out on the now paved road, the pleasant, green farmland is beckoning more prospective homeowners, who are already beginning to dot the landscape with unregulated houses.

Statistical Data

This hypothetical sketch of the life story of a fringe neighborhood from farmland to city blocks has been told without interruption for statistics. The omission was intentional. Far more important than statistics are the human elements that go into the development of a social and environmental structure. With the sketch as a guide, some

factual details can now be filled in. In the spring of 1952 a questionnaire on population growth, area development, water and sewerage, and fire protection was sent to city managers and health departments in fifteen major cities in North Carolina, as well as in cities in other areas in the United States and Canada. More than 90 per cent of the questionnaires were returned with figures and estimates, and many were accompanied by enthusiastic letters indicating an intense interest and a great need. The reports from North Carolina provide some pertinent data.

When all fifteen reports from North Carolina were tabulated, it was found that the population of the average North Carolina city grew from 28,000 to 34,200—22 per cent—from 1940 to 1950. At the same time its fringe area rose in population from an average of 12,600 in 1940 to 21,400 in 1950—an increase of 70 per cent. Average city areas increased from 7 sq miles in 1940 to 8.5 sq miles in 1950—25 per cent—but their fringe areas grew from 8 to only 9 sq miles—13.5 per cent. From these data it is obvious that 70 per cent more people are living on only 13.5 per cent more land and the population density of fringe areas has increased at more than twice the rate of cities and towns.

From 1940 to 1950 city water plant output increased from 3 mgd to 5.5 mgd—83 per cent—while water consumption in cities increased from 110 gpcd to 159 gpcd, or 44.5 per cent. Fringe area water use increased 500 per cent in the same period, but this figure is misleading. The fringe used 11.5 per cent of the total water output of cities in 1950 and 6 per cent of the total in 1940. Thus, there was an increase of only 5.5 per cent in relative suburban use of water. This means that people in the fringe areas have less water than city people. In some areas, of course, water is supplied from private sources, most of which are not supervised in any way.

Figures on fire protection in North Carolina fringe areas show that 12.5 per cent of the fringe areas had hydrants, adequate or otherwise, in 1940; in 1950, this figure had increased to 26 per cent—a rise of 110 per cent—but 74 per cent were still unprotected.

It is not now, nor has it ever been, profitable for cities to sell water to fringe areas. A total of 58 per cent of the cities and towns reported that they actually lose money on water sold to suburban areas even though they charge twice as much for it. The loss is probably in capital depreciation.

Community sewerage presents an even worse picture. While city sewerage facilities increased from 68 per cent of the total needed in 1940 to 96 per cent in 1950, the fringe areas served by municipal sewerage increased from 2.5 to only 12.5 per cent. Furthermore, 9 out of 15 cities report that less than 1 per cent of the fringe area is served by community sewerage. As 80 per cent report that sewerage service to fringe areas is unprofitable, it is unlikely that the cities and towns will take steps to improve the situation. Obviously, municipal sewerage has been supplanted in fringe areas by a seemingly cheaper water-carried waste disposal system—the septic tank. In Gaston County, N.C., approximately 70 septic tanks are installed each month. In 1951 the figure was 50 a month. Within ten years, at the present rate, there will be 8,000–10,000 septic tanks in Gaston County. Since septic tanks are relatively short lived, the replacement rate in ten years will be 50 per month. Adding this amount to the number of new installations will require a staff of five men who do

nothing but control, condemn, and inspect septic tanks.

Gastonia and Gaston County are not alone in this problem. Other cities, such as Burlington, N.C., with a fringe area almost twice as populous as the city, are equally threatened with a ring of unregulated, unsewered settlements.

Water and sewerage are just two of at least eleven major facilities and services that a community needs for healthful living. The other nine are: garbage collection and disposal, drainage and mosquito control, fire protection, police protection, street maintenance, recreation facilities and parks, traffic regulation, insect and rodent control, and rabies control. In addition, there are the purely regulatory needs of communities, such as housing codes, zoning, and nuisance abatement, which can be met only where there is organization.

The people in fringe areas spend as much on extra water rates or well construction, septic tanks, private garbage collection, and fire insurance and losses as do city people on taxes, and they have less to show for it. The cost of a well for a private home runs from $422 for a dug well with an electric pump to $1,102 for a drilled well with a 6-in. casing. Septic tanks average approximately $185 for an approved layout. Maintenance and operation of these two facilities alone, privately, costs $50–$200 per year. Public garbage collection, drainage, and other facilities usually provided by cities would easily bring down the cost of living in fringe areas to approximately that in a city. Housing regulation, zoning, recreational facilities, and nuisance abatement are seldom available outside municipal areas.

The fringe area, then, is a community with a fairly dense population, without regulation, and with few facilities—a people without government. True, the state government has regulations, but because they are not specific for fringe areas, they cannot be used to control the growth and development of such areas. County governments have been given little authority to regulate or provide the necessary basic requirements for fringe areas. City-county planning commissions authorized by the state legislature can do little more than zone. They cannot tax or issue bonds for facilities or service.

The fringe area, therefore, desperately needs a government of its own. In North Carolina, and in most other states, such a government can be provided at very little expense. It is called a sanitary district and was specifically designed for such areas.

Sanitary Districts

The legal incorporation of a community into a sanitary district in North Carolina is accomplished through the power of the state board of health, which, on receipt of a petition signed by 51 per cent of the freeholders (landowners and lessees) and forwarded through the county commissioners, holds hearings, studies the community and its needs, and incorporates it into a legal body for the sole purpose of protecting the health and well-being of the people. A sanitary district board of three men, democratically elected and usually serving without pay, can make health regulations which protect its constituents against nuisances, set up building codes to prevent slums, and hold bond elections for funds to provide community water supplies, sewerage, garbage collection, fire protection, and even police. The sanitary district board can do almost anything for the fringe that a city government does for its people, and the cost is usually less.

Sanitary districts can even include cities and towns where unification makes for efficiency and economy. Such an area has existed for some years surrounding and including Roanoke Rapids and Rosemary, N.C. This sanitary district actually owns the water and sewer facilities, selling service to the municipalities within it. The bonded indebtedness is $390,000, and the tax rate is $0.15 per $100 valuation.

Asheville, N.C., was at one time almost completely surrounded by sanitary districts, with which the city made contracts for facilities and service. Four of these districts have, however, been dissolved and annexed to the city, which assumed the remainder of their debt. The city acquired wholesome communities with standard facilities, and replacement of substandard facilities was avoided.

Gastonia, N.C., with a population of 27,000, is surrounded by a fringe containing 28,000 people, including the towns of Dallas and Lowell and the Ranlo area, as well as many industrial entities. Half the population of Gaston County lives in Gastonia and its suburbs. In such a situation, a single, all-inclusive sanitary district could be formed to provide needed regulation and facilities for the entire area, or densely populated sections outside the municipality might form several sanitary districts which could negotiate on more favorable terms with the municipality for service and facilities, and for eventual annexation if it became desirable.

When a sanitary district is dissolved, as often happens, it must be free of debt, as the debt of a sanitary district is a lien against all its property. Because only basic facilities are provided and because revenue from the sale of water and sewer service often amortizes the bonds without the need of taxation, the debt is usually assumed by the city which annexes the district.

Sanitary district taxes, if any, are collected with county taxes by the county tax collector. Bills for service are rendered by the facility or, if service from an adjacent city is used, by the municipal facility.

There are 25 sanitary districts in North Carolina in 15 different counties. The oldest, formed in 1927, is Swannonoa Sanitary Dist. in Buncombe County. Water is provided by 23 districts and sewerage by 20, with 18 providing both. One of the most recent bond elections was held in the Catawba Heights Sanitary Dist. in Gaston County in 1951, after an extension of the district boundary. The district was originally incorporated in 1940 and was relatively dormant for 11 years. The bond election provided for the issuance of $165,000 in bonds to pay for water mains and fire protection. There is no tax. Bonds will be amortized by revenue from the retail sale of water purchased wholesale from the town of Mount Holly.

The organization of densely populated communities outside municipalities to provide the regulation and sanitary facilities necessary for a healthful environment is a basic need in North Carolina. This organization can be accomplished through the formation of sanitary districts by the state board of health.

It is the responsibility of city and town planners and governments, county governments, water and sewer operators, state and local health departments, and the state government to make a determined effort to inform the people of the hazards and heartaches created by unregulated fringe areas, and to help them organize for the present and—even more important—for the future.

Legal Liability of Utilities for Service

By Harold Raines

A paper presented on Oct. 30, 1952, at the California Section Meeting, Pasadena, Calif., by Harold Raines, Atty., East Bay Munic. Utility Dist., Oakland, Calif.

VOLUMES have been written on the subject of the legal liability of utilities to render service. The present paper will discuss a few of the legal problems involved, as illustrated in specific cases. No distinction will be made between publicly and privately owned utilities, because the author believes that the principles under consideration are applicable to both. Neither will any attempt be made to consider the jurisdiction or powers of state public utilities commissions or any special charter or statutory provisions regulating particular utilities. The paper is also limited, with minor exceptions, to a discussion of what the law appears to be as enunciated by California courts.

Rule of Service

The obligation of the utility for service has been stated in one legal text (*1*) as follows:

> The primary duty of a public utility is to serve on reasonable terms all those who desire the service it renders, and it may not choose to serve only the portion of the territory covered by its franchise which is presently profitable for it to serve. Upon the dedication of a public utility to a public use and in return for the grant to it of a public franchise, the public utility is under a legal obligation to render adequate and reasonably efficient service impartially, without unjust discrimination, and at reasonable rates, to all members of the public to whom its public use and scope of operation extend who apply for such service and comply with the reasonable rules and regulations of the public utility.

The right of the consumer has been stated thus by one of the California appellate courts (*2*):

> . . . where a system to supply water for public use is established, all persons to whose use the water is appropriated or dedicated are vested with a right to have the supply continued by whosoever may be in control, and may enforce the right against such persons, whether a municipality or a private corporation or an individual.

The liability of the utility to render service may be legally enforced by the consumer in at least three ways:

1. By a suit to enjoin the utility from proceeding in a way injurious to the consumer, as by shutting off his water (*3, 4*).

2. By a suit in mandamus, which is a special legal proceeding to compel the performance of an act that the law specially requires as a duty resulting from an office or trust. For example, this proceeding has been employed to compel the utility to extend its mains (*5–9*).

3. By an action for damages for injuries sustained by the consumer or his property from the failure or refusal of

the utility to supply water (*2, 4, 10, 11*). The measure of the consumer's damage depends upon the facts of each case but might include damages for property destruction; loss of crops, gardens, and lawns; expense and inconvenience; loss of rent; and the like (*12*).

Reasonable Rates and Rules

From the utility's standpoint, the most important limitation on the general obligation of rendering public service is that which makes the service subject to the payment of reasonable rates by the consumer and to reasonable rules and regulations promulgated by the utility. This principle is well recognized (*4*), but, as is true of most general principles, its application involves difficulties. For example, when is a rule or regulation "reasonable"? The California Supreme Court has said that the question of the reasonableness of a rule reposes in the authorized person, body, or commission and the customer cannot set up his own standard of reasonableness (*3, 7*). The irate consumer whose pocketbook is affected, or who is without water, is not, however, usually inclined to agree either with the court or with the utility that a particular charge or rule is reasonable.

The courts have been struggling with this vexing problem for years and will continue to do so because, in the end, each case must be decided upon its own merits and its own facts. Invariably, each case differs in some degree from its predecessors, but, to give one example, it has been stated that a utility cannot refuse to render service because of some collateral matter not related to the service (*1*). Thus, in a Michigan case (*13*), the refusal of the utility to furnish water and light unless a septic tank was installed on the consumer's premises was held to be unreasonable; the septic tank had no relation to the utility's duty to furnish service and its right to be paid therefor, and the matter of sewage disposal was a problem for the health authorities.

Main Extensions

One of the chief battlegrounds between the customer and the utility, insofar as the reasonableness of charges and rules is concerned, is in the field of water main extensions. With the tremendous growth and expansion of most California communities during recent years, the problem has been aggravated. What is the legal liability of the water utility for the extension of its service facilities? The problem has been before the state's appellate courts in several cases (*5, 14, 15*), most of them not very recent, and it is possible to draw some conclusions from them.

This obligation has been stated by the California Supreme Court in a leading case (*5*) as follows:

> . . . when the [company] accepted the franchise offered by the state and undertook to supply the municipality of San Francisco and its inhabitants with water, it assumed a public duty to be discharged for the public benefit: a community service commensurate with the offer of the franchise which involved the duty of providing a service system . . . reasonably adequate to meet the wants of the municipality not only at the time it began its service but likewise to keep pace with the growth of the municipality, and to gradually extend its system as the reasonable wants of the growing community might require. . . .

This quotation may be surprising because it appears to impose an obligation on the utility which actually surpasses the bounds of normal utility practice. The court does, however, go on to set limitations upon its previous pronouncement, stating that the right

of the citizen to demand the extension of service facilities is not unqualified, but subject to "reasonableness." In other words, not only must the utility act reasonably in its policies and practices of extending its distribution facilities, but the consumer also is restricted by the rule of reasonableness in his demand for service. The court continued:

The right to require the service and the duty of furnishing it by an extension of the water system is to be determined from a consideration of the reasonableness of the demand therefor. It would hardly be claimed that the obligation of a water company exercising a public service franchise would require it on the demand of an inhabitant of the city, or even a number of them, residing at a long distance from a point in the city to which its mains are already extended, to further excavate the streets of the municipality at its own expense and extend its mains to them, where the rates to be charged for the water to be delivered would but to a slight extent compensate the company for the expenditures entailed in doing so—in fact, without any certainty that there would be a continuous consumption of water or a continuous payment of rates even after it was brought to them. On the other hand, where the extension of an existing main if made only for a few feet would supply the water service, the demand for making such an extension would obviously be a reasonable one as the rates to be charged would ordinarily compensate for the expenditure made by the company.

The financial burden on the utility is not the controlling test of the reasonableness of the demand, because, as further stated by the court:

. . . the water rates established as a whole between the public service corporation and the city by the public body to which that duty is committed must be sufficient to yield a fair, just, and reasonable income on the property of the company devoted to public use which would include such necessary expenditures. But additional expenditure by the company or an additional burden on the water rate payers as a whole should not be imposed for the benefit of a particular portion of the community unless a reasonable necessity for it exists. Whether it does or not is to be determined by a consideration of the facts in each particular case and, among other things, by a consideration of the duties of the company, the rights of its stockholders, the supply of water which the company may control for distribution, the facilities for making extensions to a locality beyond its present point of service, the rights of existing customers, the wants and necessities of the locality demanding it, and how far the right of the community as a whole may be affected by the demanded extension.

This case involved a San Francisco area of eight square blocks occupied by more than a hundred homes and an equal number of families. To serve the area required the extension of the then privately owned company's existing mains and distribution facilities for approximately 2,000 ft. The residents of the area had "offered to pay all lawful rates and charges" of the utility therefor. The company, for reasons which are not apparent from the decision, flatly refused to make the extensions on the ground that it had no legal liability to do so. The court differed and held the company liable for the extensions and service of water to the area. It is rather difficult at this late date to understand the company's position in view of the willingness of the people to pay for the service.

That case illustrates what could be an unreasonable position of the utility regarding its obligation to serve. Several cases in which the unreasonableness was on the part of the consumers will now be discussed. In one of these

(*8*), the request for service was made by a person whose property was a mile beyond the end of the city's existing main and at an elevation of 200 ft above any reservoir from which the water could be provided. To comply with the demand, the city would have been compelled to extend its main and construct a new reservoir. There were other factors involved in the case, but the appellate court held that it was unreasonable to require the city to construct an expensive distribution system to reach isolated inhabitants or to supply one or two persons living in remote places.

In another case (*16*) coming before the appellate court, the water company operated only a gravity flow distribution system, which was incapable physically of serving a new subdivision of 1,600 lots situated at an elevation. The parties entered into a contract of a familiar type, under which the subdivider advanced the cost and the utility constructed the facilities necessary to serve the subdivision. The lawsuit arose, not over the service obligation, but over the interpretation of the contract. The court reiterated these principles, which seem to be established in the law:

1. If the land had already been subdivided and occupied by a population sufficient to warrant the expense of the change in the utility's system and to assure it of a return on its investment, it would have been compelled to furnish the service.

2. Under the facts in this case, the utility could not have been compelled to furnish the service at its expense, because this would have necessitated a complete new distribution system.

3. When the subdivider advanced the cost of the installation, the latter objection was removed and the utility was obligated to supply the water.

The foregoing cases appear to have been chiefly concerned with the problem of the extension of the distribution main or grid, as distinguished from the service pipe from such a main to a single consumer's premises. The principles of the cases previously discussed are equally applicable, however, to the latter situation.

In one California case (*7*), the water department of a city was tendered the sum of $15 for a meter connection, and the applicant demanded a main extension. The utility refused to make the extension unless the applicant advanced the sum of $1,480, an amount apparently determined by the city's regulations governing extensions. The appellate court refused relief to the applicant because he had failed to comply with the reasonable regulations of the utility.

Discontinuance or Failure of Service

Although the problems of the utility are acute as regards its obligation to extend its mains, it is apparent that the most rugged individualists among consumers reserve their efforts for rate struggles. It is amazing to contemplate the cases which have been carried through the courts for trivial water bills.

The case of *Schultz* v. *Lakeport* (*4*), decided by the California Supreme Court in 1936, well illustrates the complications that can arise. The plaintiff resided in Lakeport, Calif., where 0.2 acre of his lot was devoted to growing a few trees, some vegetables, and a small lawn. He received water from the municipal system between 1927 and 1932 but, for some reason, was never billed for the service. In June 1932 the town belatedly billed him for arrears amounting to $129.65. He refused to pay, but did tender the amount of his May bill. His water was thereupon shut off and the town sued him in the justice's court and secured judg-

ment only for $36.69, the remainder of the bill being held to be barred by the statute of limitations. The plaintiff paid this amount and his service was restored in October. He then sued the town for $662.15 alleged damages to his vegetation during the enforced drought, plus $26.50 for having to haul water in cans. The case wound up in the supreme court, which affirmed a judgment in his favor for $226.50, ruling that:

> . . . if the facts indicate that there is ground in good faith to dispute the correctness of the amount claimed, the consumer, upon tendering the rate for the current term, is entitled to have the service continued pending a settlement of the disputed overdue account.

The court in this case also gave some attention to the basis of the right of the utility to discontinue service. It said:

> The rationale of the decided cases appears to be that the summary power of shutting off the water to coerce payment of current bills or water rent is conceded to be vested in the company furnishing such commodity so as to afford it a means of conducting its business in an orderly, efficient, and economical manner, without the expense attendant upon litigating nuemerous small claims as to which there can be no dispute or question of their correctness; but that such right or power is not deemed to exist concurrently with the necessity to litigate a claim disputed in good faith.

In such instances, the courts have rather uniformly favored the customer on the theory that water is "a prime necessity of life," of which he should not be deprived without adequate cause *(4)*. Sometimes in the rush of daily business and the constant recurrence of problems, utilities tend to lose sight of the vital nature of the service they render.

Another hardy consumer was involved in an earlier case *(17)* before a district court of appeal. He had a contract with the utility for irrigation water. Subsequently, a rule of the railroad commission changed the time for making payments under the contract. The difference amounted only to $1.53 for this customer, but he refused to pay it. The water was, therefore, shut off, apparently to his detriment, because he later sued the utility for $7,000 for damages to his crops. He was denied redress. The court made a statement in its opinion which appears well worth noting:

> The plaintiff may pride himself upon his firmness in insisting upon what he conceived to be his rights, and he is entitled to whatever satisfaction that may bring, but the law does not permit such pride to prevent the payment, although not due, of less than $2.00 in order to save the loss of possibly thousands of dollars.

If he valued his crops, this consumer should have made a tender of the amount first and fought later. (See also the Henrici case *(10)*, previously mentioned.)

This legal requirement of some affirmative action by the consumer to protect himself appears to be an extension to the utility field of a familiar legal principle that a person claiming to be injured by the act of another must use reasonable efforts to minimize his damage. It has been held, however, that the utility consumer faced with a shutoff of water service is not required to incur more than "slight expense" *(2)* or "reasonable expense" *(4)* in an attempt to prevent his damage from mounting. For example, he cannot be required to procure water from another source at a relatively large increase in cost *(18)*.

There are several other principles involved in this matter of discontinuance of service which might be mentioned. They appear to be supported by general considerations and by legal authority outside California, at least:

1. When water is being supplied, under separate applications or contracts, to two or more premises owned by the same person, the utility may not discontinue service to both premises because of the nonpayment of a bill for service to one. The theory is, of course, that two or more separate and distinct contracts exist between the utility and the property owner.

2. For similar reasons, if water is being supplied to certain premises, the service may not be discontinued because of an old indebtedness arising under a prior contract for service elsewhere.

3. The legality of a regulation of the utility requiring the applicant to discharge an outstanding indebtedness for prior service at another location before granting his present request for service has not been established beyond question. Such a regulation has been approved in a Tennessee case *(19)*, but there is a noticeable trend to the contrary elsewhere *(20)*. A utility rule based upon this principle would, however, appear to be reasonable and justifiable as it permits the utility to operate its business efficiently and economically, without the annoyance of litigating numerous petty claims—a point previously made in the Schultz case *(4)*.

Before leaving the problem of discontinuance of service against the consumer's will, one more case is worth discussing. Although it does not involve a delinquent account, it does emphasize a certain responsibility of the utility for service. In this California case *(11)*, the consumer owned a tract of agricultural land situated on a height within the city. The property was served with water from the municipal system by gravity flow from a tank to which water was pumped from a lower reservoir. The booster pump broke down one July day, and service to the particular property ceased for three months until the pump was repaired or replaced. The city could physically have obtained water to supply the plaintiff's land from another utility operating in the vicinity, but the two utilities could not agree upon the cost of the connection. The appellate court held that, under these circumstances, the city was negligent and was liable in damages for the injury sustained by the consumer. This case illustrates the fact that there is some obligation upon the utility to minimize the amount of the consumer's damage and also that the utility must make repairs with reasonable promptness.

The problem of service to elevated or hillside areas presents a host of difficulties all its own. One of the most vexatious concerns the hillside area which once was adequately served but has since grown just enough so that the present distribution facilities are overtaxed, although it has not grown enough to warrant an expensive outlay to improve the system. It has been the practice of some utilities, under these conditions, to require new applicants for service to sign agreements accepting substandard service and relieving the utility from liability arising therefrom. Such an arrangement appears to be consistent with principles previously discussed, for it might be questionable whether the utility could refuse service altogether to the new applicants. For example, it was held in an Indiana case *(21)* that a gas company cannot refuse service to new applicants

because the pressure has fallen so low that existing customers cannot be supplied; the new applicants are entitled to share in such supply as exists.

The trouble in such a hilltop area breaks out again when the property changes hands and the new occupant is without knowledge of the substandard service conditions or of his predecessor's agreement with the utility. The problem is, accordingly, constantly recurring and is never settled until the distribution system is improved. One practical answer to the latter situation —admittedly only a partial solution— is to record the original agreement in the county recorder's office in the hope that it will run with the land through the various transfers and will at least give constructive notice to prospective purchasers of the property. Even recording presents some difficulties, although it is understood that some utilities in California have adopted it.

At this point it is appropriate to discuss briefly the problem of the utility faced with an inadequate water supply. The law appears to have been well settled over a number of years that, in such a situation, the earlier consumers have no vested right to water in preference to later consumers and the existing supply must be prorated among them all *(22)*. This principle applies whether the shortage resulted from added consumers or from other causes for which the utility was not responsible *(23)*.

A limitation upon this rule resulted from the enactment in 1949 of a California statute *(24)* which authorizes the governing body of a distributor of a public water supply, whether publicly or privately owned, to declare a water shortage emergency condition; provided, however, that it first holds a public hearing after publication of notice for 7 days. Upon declaring the emergency in this manner, the governing body must adopt regulations and restrictions on the use of the existing supply—including priority for domestic use, sanitation, and fire protection— without discrimination among consumers using water for the same purposes. Thereafter the statute specifically authorizes these regulations and restrictions to include provisions denying applications for new or additional service connections. In the latter respect a new concept appears to be introduced.

Special Rate Contracts

Free-water or special rate contracts may be service contracts pure and simple, or the special rate may have been granted to the consumer in exchange for special consideration, such as the conveyance of property. The problems presented to the utility by such agreements are obvious, and sooner or later a question arises on the obligation of the utility to continue service at the contractual rate.

The San Francisco water utility, while under private ownership, had agreed to special rate provisions in certain contracts dating as far back as the 1880's. Some provided for free water, while others conferred rates lower than the city's current water rates. They had all apparently been entered into by the private company in exchange for water rights or pipeline rights of way outside the city. The city respected these agreements when it acquired the utility property in 1930 and itself entered into one free-water contract in 1937 with the toll bridge authority in exchange for the right to use the Bay Bridge for a pipeline to Yerba Buena Island. In 1952 the city attorney made a legal survey of the problem and reached these conclusions:

1. Public regulation of utility rates is a function within the police power.

2. Exercise of the police power, in future action, cannot be contracted away.

3. Every contract purporting to fix a rate between utility and customer must be taken to contemplate future exercise of the rate-fixing power.

4. Consequently, every such contract is subject thereafter to exercise of the rate-fixing power.

The city attorney, therefore, decided that the public authorities of San Francisco, vested by law with the rate-fixing power, had the right to impose the city's current rate schedule upon all consumers alike, regardless of the terms of the special contracts. This opinion is amply supported by legal authority and the conclusion appears sound.

A number of the cases cited by the city attorney confirm the exercise of the same power by the state public utilities commission. Thus, the same conclusion could be applicable to both municipally or privately owned water utilities.

This opinion leaves open the question of the liability of the utility to a consumer who has transferred valuable property rights to the utility in exchange for the special water rate. Upon cancellation of the special rate, such a consumer might be entitled to compensation for the property which he had conveyed to the utility. An action to recover such compensation would be in the nature of an inverse condemnation. Of course, if the contract had been in existence for many years, it might be difficult, if not impossible, to determine the value of the rights transferred to the utility. Moreover, it could happen that the consumer, over the years, had received by way of the special rate the full value of the property which he surrendered, or it could well be that he had received more than full value. The city attorney points out, however, that, in any event, the utility could not be deprived of the property transferred to it and used in utility service. This conclusion is based upon the well-established principle that, once property has been devoted to public use, the public interest has intervened and the owner or former owner may not interfere with that use but is confined to an action for damages.

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Meter Testing and Repair in the One-Man Water Works

By L. A. Gutsch and John L. Ford Sr.

A paper presented at the fall 1952 Indiana Section district meetings by L. A. Gutsch, Supt., Washington Water Works, Washington, Ind., and John L. Ford Sr., Vice-Pres. and Secy., Ford Meter Box Co., Inc., Wabash, Ind.

OPERATING a one-man water works is a big job because it includes nearly all the duties involved in running a large water system. Those who are in sole charge of their utilities have a tremendous responsibility to protect the health and lives of the people in their communities. A one-man water works may serve only a small population, but that one man has no relief and is always on the spot.

Although the operator of a one-man water works may have only 100 or 200 services, he should account for as large a percentage as possible of the water pumped. This can be done adequately only with meters. A saving of 8.33 per cent of the annual pumpage represents a yearly reduction of one month's expenses for fuel or power, as well as for chlorine and other items.

The best way to begin a program of water accounting is to check the meters being used. Meter inaccuracy represents the greatest potential loss in the average water distribution system. The Cast Iron Pipe Research Assn. estimates that main losses should be no more than 2 per cent and service losses no more than 3 per cent. The difference between this 5 per cent and whatever the actual unaccounted-for total may be is probably made up almost entirely of meter slippage—underregistration and nonregistration. Proper meter testing and maintenance will keep such inaccuracies to a minimum and should pay an excellent return on the investment.

Residential Water Use

Before discussing a program of testing and repair, it is well to analyze the service a meter should render. A typical water customer living in a private home on a small lot will have one bathroom, a kitchen sink, possibly a washroom in the basement or on the first floor, and a sill cock for sprinkling. It may be assumed that he has a wife and two children and that, together, they would use water in the quantities shown in Fig. 1.

The rates of flow at which water is drawn may range from 8 gpm for sprinkling or filling the bathtub to the very low rate at which the toilet tank fills as the float ball rises and shuts off the flow. Some of these drafts may occur together; one survey indicates the following percentages of total water drawn at various rates:

Rate *gpm*	Per Cent of Total
8–12	6
6–8	13
4–6	51
2–4	11
1–2	5
0.5–1	2
0.25–0.5	4
under 0.25	8

In the average dwelling, the total time each day during which water is actually being used is less than 1 hour. That leaves more than 23 hours with no useful flows, when the water passing through the meter simply supplies leaks in faucets, toilets, and piping. These leaks are generally at such low rates of flow that they will not register accurately or at all on any but a sensitive meter. The surprising totals that drips and small leaks can reach in 23 hours (five drops per second amounts to 17 gal) must be borne in mind constantly in planning a program of meter testing and repairing.

Figure 1 also shows the performance curves of a good ⅝-in. meter (left or top curve) and another ⅝-in. meter which is all too typical of many in service. The poor meter will not register a flow of ¼ gpm. A leak at that rate amounts to more than 300 gpd of unaccounted-for water, nearly three times the registered use. This may be an exceptional instance, but it points clearly to the importance of meter performance at low flows.

Testing and Repair

The one-man water works does not need elaborate testing equipment. It would be desirable to have an accurately calibrated tank of 10-gal or 1-cu ft capacity to check against or to prove accuracy to a customer. Meters can be connected in a test line by ordinary couplings or by a yoke. A rate-of-flow indicator is useful but not necessary. A ¼-gpm rate can be set quickly and easily by adjusting a needle valve on the discharge pipe until the flow fills a 1-qt milk bottle in 1 min. Higher or lower rates can be set by the same method.

New or factory-repaired meters are geared for accuracy within allowed limits but can be checked by testing at about 1½ gpm. After a period of service it makes good sense to test a meter at a low rate, say ¼ gpm. If it registers 90 per cent, it is still a good meter; if it registers 50 per cent or less, it should not be used as is, even though it may be quite accurate on larger flows. The operator can run a low-flow test on several meters in series, and, by putting one or two new meters in the line, he can obtain an interesting and useful comparison.

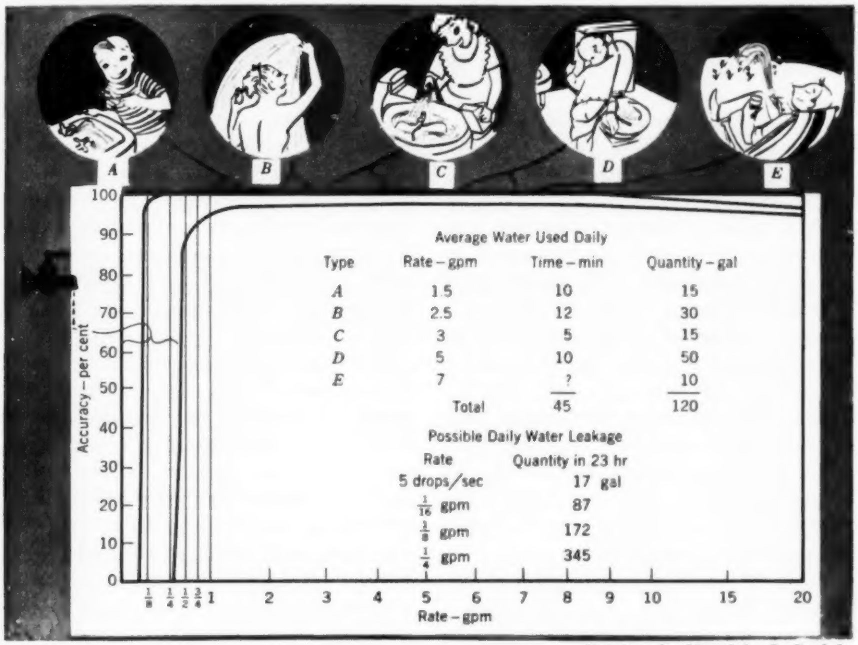
The operator of a one-man water works can test the few meters he has that are larger than ⅝-in. by running them in series with smaller meters of known accuracy. If the rate of flow can be carried past the "hump" of the performance curve of the large meter, that should be sufficient.

The small operator can hardly be expected to have a lot of equipment and tools for the repair of only 100 or 200 meters. The water works man is usually a fair mechanic, however, and, with a little experience, can take a meter apart, clean it, and put it together again. Such repair work requires only a few items like gaskets, stuffing-box packing, and register glasses. It is a great advantage if all the meters are of one make and model.

Many water works with less than 500 meters are sending those that are inaccurate or in need of repair back to

the factory or to meter repair companies. According to several operators, these repairs, including freight, amount to approximately $10 for each $\frac{5}{8}$-in. meter. If the cost of repair exceeds 50 per cent of the price of a new meter, consideration should be given to junking the old one, particularly if it is not a current model. Some older models become obsolete from time to time. Even though they may be brought back to good performance, it may be difficult to obtain parts later on.

Intelligent meter maintenance and testing show prompt results in dollars and cents. The one-man water works operator can substantially improve the financial success of his utility by putting such a program into operation. The operator would receive personal satisfaction and public recognition, and, perhaps, material benefits as well.



Drawings by Mrs. John L. Ford Jr.

Fig. 1. Meter Registration and Residential Water Use

The graph compares the performance of a good meter (curve at left and top) and a poor one. The table shows the quantity of water consumed daily for the purposes illustrated. The total period of useful flow is less than 1 hour a day. Also indicated is the quantity of water wasted at various rates of leakage.

Fundamentals of Water Well Operation and Maintenance

By E. W. Bennison

A paper presented on Sept. 19, 1952, at the Ohio Section Meeting, Cincinnati, Ohio, by E. W. Bennison, Office Engr., Edward E. Johnson, Inc., St. Paul, Minn.

THE value of efficient operation and maintenance of water wells is often too little appreciated. More attention is generally given to the initial installation of pumping equipment than to the construction of the well itself or to its subsequent operation and maintenance. The operation and maintenance of water wells should not be included in the problems of pumping but should be regarded as a separate problem directly related to ground water conditions and well construction.

O. E. Meinzer, formerly chief of the Ground Water Div., U.S. Geological Survey, once said that the most urgent problems in water hydrology are those relating to the rate at which rock formations will supply water to wells in specified areas, not during a day, a month, or a year, but permanently. Although this statement was made with the problems of ground water supply in mind, it also applies to the construction, operation, and maintenance of water wells.

All water wells fall into two classes: shallow and deep rock. Shallow wells obtain their water from unconsolidated formations lying above the basal rock, while deep-rock wells obtain water from the basal rock. The techniques and methods of construction differ greatly for the two types of wells. Consequently, the problems connected with well operation and maintenance are partially dependent on the type in use.

Shallow wells must depend on openings of some kind in their casings to let water into them, while deep-rock wells depend on openings in the formation for their water supply. These openings in shallow wells vary from the open bottoms of well casings to all sorts of punched, perforated, sawed, and even burned openings. Carefully designed well screens are intended to serve two purposes: to let water into the well and at the same time to keep out the finer particles of the formation in which the screen is placed. Many shallow well failures are due to poorly designed casing openings or inefficient well screens.

There are other causes for well failures, but the three most common are:

1. Failures due to the casing openings or screens becoming clogged, incrusted, or corroded. Such failures are indicated by increased drawdowns or by the continuous pumping of fine sand.

2. Failures due to pumping the ground water reservoir at rates in excess of the rate of replenishment. Such failures are indicated by a cumulative

lowering of the static and pumping levels in the well, accompanied by a decrease in capacity.

3. Failures due to faulty initial well construction or to mechanical deterioration of the well during its life. Such failures are indicated by difficulty in setting and operating pumping equipment, by partial or total collapse of the well casing, or by contamination of the water being pumped.

Before anyone can properly operate or maintain a water well, he should have a working knowledge of the probable causes of well troubles and what can be done to eliminate them. Like human beings, water wells live only so long, regardless of how well they are constructed and cared for during their lifetime. Fifty years is a long life for the average water well. Shallow wells are shorter lived than deep wells, but all of them fail sooner or later.

Incrustation and Corrosion

Every operator of a water well should have some knowledge of the basic principles of incrustation and corrosion. *Corrosion* of metals is a chemical action set up by the environment to which they are exposed, resulting in the deterioration or eating away of the metal. *Incrustation,* on the other hand, is an accumulation of mineral salts or other extraneous matter in and immediately behind the openings in a well casing. These terms are frequently confused. Figures 1 and 2 contrast their effects.

Corrosion of well screens is not as prevalent as incrustation, but it is more harmful, because the metal itself is destroyed. Without considerable experience and some investigation it is difficult to recognize the type of corrosion involved, as there are at least six different forms of corrosion, and the trouble may be due to any one of them.

Direct chemical corrosion is the most common form encountered in wells. It involves nothing but simple solution of the metal as a result of the chemical nature of the water. It is evidenced by a gradual enlarging of the well openings, permitting the well to pump fine sand.

Dezincification of brass and graphitization of iron are another form of corrosion frequently noted in water wells. It is the selective removal of an element from an alloy, such as the removal of zinc from brass. When this form of corrosion occurs, the metal is left in its original form but is substantially weakened. Examination with a microscope will reveal the extent of the structural change, but it is practically impossible to make such an examination without removing the corroded parts. This type of corrosion may be responsible for sudden failures of well casings or screens and of pumping equipment that appears to be sound.

Intergranular corrosion is a localized chemical reaction at the boundaries of metallic crystals. It is an amalgamating action and very destructive. Fortunately, it is not often encountered in wells. Little can be done to guard against it, except to avoid the use of amalgamating agents.

Galvanic or bimetallic corrosion is a localized attack which often results when two dissimilar metals are connected in an electrolyte. Under such conditions, a simple electric cell is created, with the anode being corroded. Almost the only thing that can be done to eliminate or retard this form of corrosion is to place lead plates in the well in such a position that they intercept and absorb the low-potential currents.

The safest protection is to use the same metal throughout the entire well, including the pumping equipment.

Concentration cell corrosion is occasionally encountered in wells, although it is rare and extremely difficult to recognize without the aid of expert chemists and physicists. It is the form of electric cell set up when one metal is placed in two different concentrations of the same electrolyte. This type of difficulty is evidenced by local corrosion occurring at random on the corroded surface.

Most *ground waters* found in sands, gravels, and similar formations are only mildly corrosive, if at all. Generally, a mineral analysis of the water will indicate the proper metal to use in the well installation. Dissolved oxygen is probably the most important constituent in determining the likelihood of ground water corrosiveness. Hydrogen sulfide is another agent which is a sure sign of corrosiveness. The balance between dissolved carbon dioxide and the carbonates of magnesium and calcium, in combination with dissolved oxygen, determines the degree of corrosiveness of most ground water, as well as the probability of incrustation. Water with a low pH (high acidity), low carbonate hardness, and high carbon dioxide content is almost certain to be corrosive. Water with a high pH and low proportion of carbon dioxide will not usually attack the metals used in wells or pumps.

The rate of corrosion is dependent on a number of factors, one of them being the rate of movement of water over the surface being corroded. To offset corrosion in wells and pumps, two general methods of approach are common: one is the use of protective coatings, and the other, the use of highly corrosion-resistant metals. Neither method has proved to be a wholly effective safeguard against corrosion.

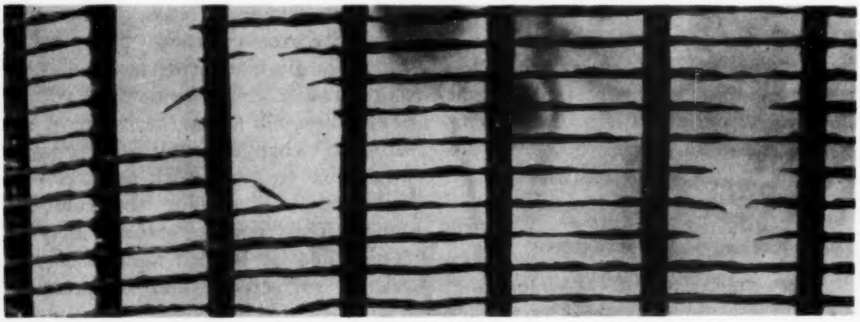


Fig. 1. Corroded Well Screen

This photograph shows a well screen destroyed by direct chemical corrosion because improper metal was used in the screen. The well can be reclaimed by installing a screen made of corrosion-resistant metal.

Incrustation of well casings, openings, and screens is a deposition of materials in and around all metal parts of wells and pumps. These accumulations are made up largely of the bicarbonates and sulfates of calcium, magnesium, sodium, and iron. Hydroxides

and oxides of iron with other substances such as chlorides, borates, and silicates may be present but only add to the amount and kind of deposits formed. Iron and manganese compounds are the most difficult to break down and remove, as they form a relatively hard deposit. Silt and clay may be in suspension in the water and contribute their bit to the accumulations of incrustation. Other agents contributing to incrustation are the iron bacteria and slime-forming organisms such as *Crenothrix*.

No way has yet been found to prevent or entirely remove these accumulations in and around well screens and pumps. All that can be done is to take steps to retard such action. One measure is to provide the maximum amount of transmitting capacity in the casing or screen openings either by rebuilding the well or by replacing it with a new one of better design. Another step is to lower the rate of pumping and increase the period of pumping. This will be effective if drawdown is materially reduced. Many well owners are finding it more economical to operate a large number of properly spaced wells, with less drawdown, than to try to obtain their requirements from a few wells having excessive drawdowns.

Wherever incrustation is present, as shown by past experience, periodic cleaning of wells and pumps should be made a regular item of maintenance. Such corrective measures should be initiated at the first suspicion of incrustation. Otherwise, costly rehabilitation may be necessary, with questionable results.

Acid treatment is by far the most common means of removing incrustation. Hydrochloric acid used with an inhibitor readily dissolves the carbonates of magnesium and calcium, as well as the hydroxides and oxides of iron and manganese. Chlorine in both liquid and gaseous form has been used with some success, especially in removing the accumulations of slime-forming organisms. This method does not, however, prevent recurrence of the trouble.

Other chemicals, such as sulfuric acid, sodium hexametaphosphate, copper sulfate, and carbon dioxide (in the form of dry ice), have been tried in many places as a means of removing incrustation, with mixed results. As yet

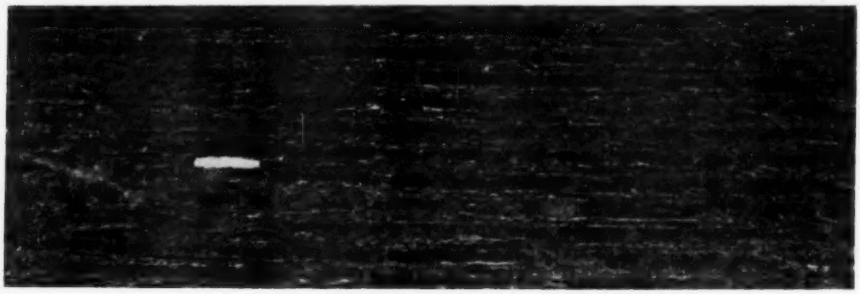


Fig. 2. Incrusted Well Screen

Acid treatment of the screen will restore the efficiency of the well, provided the screen is constructed of noncorroding metal.

there is no established technique for treating wells with chemicals or removing accumulations by the use of scrapers, brushes, compressed air, water, or steam. Each job of this kind must be carefully studied, taking into account the chemistry involved—as the amount of incrustation depends primarily on the minerals carried by the ground water—and also the rate of pumpage.

Well failures due to a low rate of ground water replenishment can be corrected only by regulating the pumping rate to conform with the replenishment rate. There is no other answer. Many have tried to maintain well supplies by installing larger wells and pumps, but the safe annual yield of a well is definitely limited to the amount of annual water replenishment of the underground reservoir.

Well failures due to poor construction, or to mechanical troubles after construction, are in the minority. Such failures are caused mostly by the use of cheap materials, poor construction methods, improperly designed screens, poor gravel treatments, and the like. These failures usually give little or no warning. A well may suddenly collapse or start pumping large quantities of formation material. Such failures can, of course, be avoided by proper design and construction. Once the well is in operation, however, little can be done to prevent failures of this type.

Deep-Rock Wells

The nature, construction, and hydraulic characteristics of deep-rock wells are so different from those of shallow wells that they require special consideration and careful supervision at all times. The maintenance and operation of deep-rock wells is largely a question of good judgment, coupled with experience. The water supply of deep wells depends upon the kind of rock in which they are drilled, its ability to transmit water, the nature of the water itself, and its source of origin. All deep-rock wells, with the exception of wells in sandstone, get their water from rock fractures or from solution channels. The water table in rock wells slopes from the surface intake to the well, usually at a much flatter slope than the water table in an unconsolidated formation. Hence, the water moves under different hydraulic conditions and invariably is in a confined rather than a free state. This means that the supply of a deep-rock well is obtained from water rising through the larger fractures to the point of discharge. Because the water level in a deep-rock well controls the water level in the formation, the yield from deep-rock wells may vary widely even though they are located in the same rock formation. On account of the presence or absence of rock fractures, one well may be much better than another even though the two are not far apart. If the fractures in the rock at the well are enlarged or increased by shooting, by the use of acids, or by mechanical means, the water level in the formation may be raised or lowered, thus decreasing or increasing the capacity of the well.

Consequently, the use of explosives in a deep-rock well is not always good practice. Shooting a deep-rock well frequently does more harm than good, as the well may be filled with rock debris or new fractures which are filled with fine material may be opened. The job of cleaning rock wells that have been shot is just as important as the shooting itself. The shooting of wells should always be carried out by persons thoroughly experienced in this

kind of work, under the supervision of someone who knows the geology of the formation.

Mechanically there is very little that can be done to maintain a deep-rock well supply. Most operators find it necessary to go into such wells occasionally for the purpose of keeping the fractures or solution channels open. The sides of the drill hole can be scraped or brushed to remove any accumulations present. If the drill hole has become partially filled with rock debris, it is cleaned out by bailing. Chemical treatment and surging are helpful in dissolving certain kinds of accumulations in the fractures.

Wells constructed in limestone, dolomite, gypsum, and similar formations often obtain their water from solution channels rather than rock fractures. Solution channels are created by the solvent action of water entering the vertical joints of the formation at the surface and then finding its way to the horizontal joints, which are fractures. The dissolving effect of water in such formations is well known. It is particularly effective above the water table where the movement is comparatively rapid and the water contains the maximum amount of carbon dioxide. It must be remembered, however, that the fractures and channels below the water table act as a network of reservoirs supplying deep-rock wells. Obviously, there may be considerable variation in the supply from the same type of formation in different localities, owing to the presence or lack of caverns and major channels. In some places, a well will pass through limestone without striking a water-bearing channel or fracture at all.

The chemical constituents of water obtained from deep-rock wells depend largely on the chemical nature of the rock itself, the rate of flow, and the temperature. As a rule, water from deep-rock wells is warmer and more highly mineralized than water from shallow wells. Although better protected against pollution, it is not at all uncommon for deep-rock wells to become polluted. The origin of such pollution is difficult to locate and trace. It may be due to carelessness in and around the well, to surface contamination originating at a considerable distance from the well, or to improper installation and operation of pumping equipment.

On account of the cost and nature of deep-rock wells, they are generally pumped at greater drawdowns than shallow wells. Air-lift pumping will sometimes maintain a supply when the conditions in the well are such that other types of equipment cannot be used. One of the chief causes of failure in deep-rock wells is the lowering of the water table or pressure level to a point at which it is no longer economical to pump the well. This again emphasizes a fundamental of good well operation—the regulation of pumping rates to the amount that can be safely withdrawn annually.

Protective Measures

In operating wells, there are a number of things that can be done to maintain and protect a ground water supply. The following suggestions are offered:

1. All wells should be located and constructed by men who are experienced in this sort of work and who have some knowledge of the occurrence and movement of ground water in various water-bearing formations.

2. All wells should be located so that they will not interfere with other wells operating in the vicinity.

3. All wells should be constructed in such a way that only water which is

free of pollution and is of usable quality can get into them.

4. All wells and pumping equipment should be constructed of materials that will resist the corrosive and erosive action of the water being pumped, as well as the action of chemicals which may be used to remove accumulations.

5. All wells should be operated at their most economical point by equipping them with pumps properly designed for the characteristics of each installation. This means that well operators should have a method of measuring the yield, drawdown, and power consumption of every pumping unit under their care.

Conclusion

Good operation and maintenance of a well supply are primarily the well owner's responsibility. He must provide the best well construction, pumping equipment, and supervision that he can obtain. The operation and maintenance of a well water supply are a great responsibility, but municipalities, industries, and private owners often take it too lightly. They are not concerned until something unfortunate happens, but when a water supply fails, there are plenty of questions asked, with the blame usually falling upon the party least responsible.

The author does not mean to imply that the operator of a water well has no responsibility, for he has. His responsibility is to inform himself regarding the wells under his care. He must know enough about the methods and materials used in constructing wells to be able to anticipate any trouble from these sources. Furthermore, he should know enough about the local water-bearing formations and the water in them to be able to advise the owner of any overpumping or reduction in supply.

The operator should insist on having the apparatus and assistance required to make periodic readings of water levels, pumping levels, quantity of water pumped, and power consumption. It is essential to make these data a matter of record, because they will be invaluable in any emergency which might arise. Such information will also be helpful in anticipating shortages due to increased demands or failure of wells and pumping equipment.

In Illinois, a recent survey disclosed the fact that, out of 23 municipal supplies from shallow wells, only one metered the pumpage. None reported making measurements of water levels, either static or pumping. The survey also disclosed that, in a group of thirteen deep-rock wells, none metered the pumpage or made any systematic effort to determine the performance of the wells. This record probably could be duplicated in any section of the country. This sad state of affairs cannot be charged entirely to the operators of well supplies, as they are often burdened with other duties, varying from dogcatcher to night watchman. It goes without saying that inefficient operation adds to operating costs. For this reason alone, operators of well supplies should be allowed to devote their entire time and ability to bettering the operating conditions of their well installations. Most operators are capable of doing their job if given the chance.

Thermistors for Depth Thermometry

By William R. Ree Jr.

A contribution to the Journal by William R. Ree Jr., San. Eng. Asst., Los Angeles Dept. of Water and Power, Los Angeles.

IN limnological studies, accurate temperature measurements at depths in reservoirs are very important. The means used for measuring these temperatures include the reversing thermometer, the depth sampler and ordinary thermometer, and the electrical resistance thermometer *(1, 2)*. Of these, the resistance thermometer offers the greatest advantages, because the temperature-sensing device need not be brought to the surface each time a reading is taken.

In the past the most commonly used temperature-sensitive element has been a fine platinum wire with a positive temperature coefficient of resistivity of approximately 0.4 per cent per degree centigrade and a total resistance of about 25 ohms at 25°C. This requires a very accurate and expensive bridge if temperature changes of 0.1°C are to be measured. The advent of the thermistor in recent years has afforded a much better temperature-sensing device *(3–6)*.

Thermistors are thermally sensitive resistors with a high negative temperature coefficient of resistance (approximately 4.4 per cent per degree centigrade at 25°C). They are available in a wide range of types with diverse and stable characteristics. The type most adaptable for depth thermometry is the Western Electric Type 14A thermistor,* which consists of a glass probe approximately 0.1 in. in diameter and 2 in. in length, with the thermally sensitive bead sealed in one end and a pair of tinned leads brought out axially from the opposite end. It has an electrical resistance of approximately 355,000 ohms at 0°C, 100,000 ohms at 25°C, and 34,000 ohms at 50°C.

The resistance of the thermistor may be read directly by using a Wheatstone bridge and a sensitive galvanometer. This measured resistance is then converted into a temperature reading by using an empirical graph or table showing the function of resistance with respect to temperature. Another method consists of impressing a small voltage on the thermistor in series with another resistor. The voltage developed across the thermistor is measured with a potentiometer, and this reading is converted to temperature by means of an empirical chart or graph. This is the system adopted at Los Angeles.

Description of Equipment

The equipment consists of three major parts: the sensing element, the control box, and the indicating instrument. These are shown in Fig. 1. The thermally sensitive element, or thermistor, is mounted at one end of a two-conductor cable. Since the thermistor itself is a fragile glass probe, it must be mounted in a protective holder. A holder made of Lucite is

* A product of Western Electric Co., New York.

used, which serves the dual purpose of protecting the thermistor and providing a waterproof cover for the electrical connections between the thermistor and the rubber-covered cable. An exploded view of this plastic holder is shown in Fig. 2.

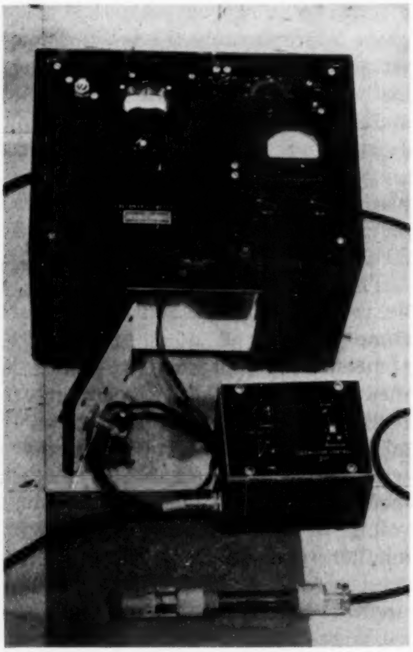


Fig. 1. Thermistor Equipment

The thermistor can be seen in the foreground, the control box in the center, and the indicating instrument in the rear.

The two-conductor rubber-covered wire is used to provide the electrical connections to the thermistor and also to suspend the unit in the reservoir during use. Painted bands or markers can be used to indicate the depth to which the thermistor has been lowered. The upper end of the cable terminates at the control box, which contains the switches and controls necessary for standardizing the apparatus, as well as the wiring for connecting it to the indicating instrument. The circuit diagram for this control box is given in Fig. 3.

In operation, a small voltage, approximately 1 v, is impressed across the thermistor, and the voltage drop across the thermistor is measured. This voltage is a function of the circuit resistance, which, in turn, depends on the temperature. A chart relating voltage to temperature permits rapid conversion.

Because the equipment is designed to be used in the field, a method of standardizing the apparatus in the field must be provided. This is accomplished by the use of the fixed resistor (R_3 in Fig. 3), which may be switched into the circuit in place of the thermistor (R_4). As R_3 is a precision resistor having a low thermal coefficient, it is used as a standard value in the field. The voltage drop across this fixed resistor is the reference value used to zero the equipment in the field.

This equipment was built to utilize the millivolt scales of the Model G Beckman * pH meter as the indicating instrument, because these meters were already used by the field personnel for routine pH tests. Any type of millivoltmeter with a range of 0–1,200 mv would be satisfactory, however.

Construction of Thermistor Holder

The protective holder consists of a center tube with threaded caps at each end (Fig. 2). The tube provides space for the soldered connections to the pigtail leads. One cap is drilled to pass

* Beckman Instruments, Inc., South Pasadena, Calif.

the two-conductor cable,* while the other cap provides a seal and protection for the thermistor proper. Each cap consists of two parts which are assembled with machine screws. The four rubber gaskets assure positive protection against water leaks.

In assembling the Lucite holder, extreme caution must be used to avoid twisting the pigtail leads of the thermistor. Experience has shown that only a slight rotation or twisting of the wires will fracture the glass probe. This holder has been developed to prevent such unnecessary breakage. When mounted in the holder, the thermistor will readily withstand normal handling in the field.

When the apparatus is being assembled, the first part to be sealed is the cable entrance of the holder. This joint is made watertight when the two pieces of plastic are tightened against the rubber gasket shown in Fig. 2. Next the threaded tube and gaskets are put into place, followed by the threaded portion of the thermistor end. At this point the thermistor is free to turn as the cap is tightened. The final assembly operation consists of fitting the gasket and protective cap in place and tightening the machine screws. In this way, rotation or twisting that might damage the unit is avoided.

Calibration of Equipment

Before the equipment can be used as a depth thermometer, it is necessary to prepare a calibration curve or chart of millivolts against temperature. This is easily done by setting up the equipment with the thermistor immersed in a controlled water bath. Set the control knobs near the midpoint and take an accurate voltage reading across the standard resistor. Turn the switch to the "thermistor" position and note the millivolt reading. Read the temperature of the water bath to 0.1°C with a calibrated thermometer. Repeat this

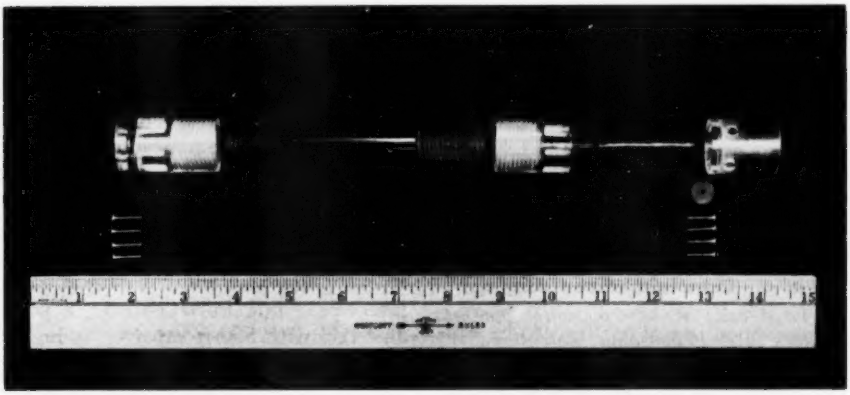


Fig. 2. Thermistor Holder

An exploded view of the Lucite holder is shown, with the size of the parts indicated by the scale.

* Such as Belden No. 18120, made by Belden Mfg. Co., Chicago.

procedure at different temperatures. Before making readings, always recheck the standard setting, readjusting the controls, if necessary, to maintain the original standard reading. The data obtained in this initial calibration can be plotted as a curve or tabulated in chart form. The latter method has been found more satisfactory for field use.

Because of variations between thermistors and slight circuit variances, a different standard setting will be found for each thermistor–control box com-

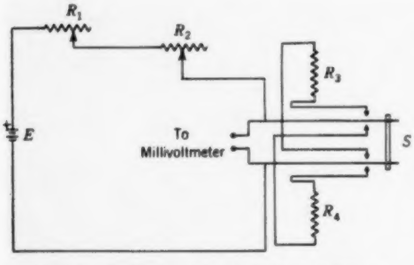


Fig. 3. Thermistor Circuit Diagram

E—*1.5-v cell;* R_1—*200,000-ohm potentiometer;* R_2—*10,000-ohm potentiometer;* R_3—*100,000-ohm resistor;* R_4—*thermistor;* S—*double-pole double-throw switch, anticapacity type.*

bination. To determine the correct standard setting, the above calibration procedure is reversed. The thermistor is immersed in a water bath of known temperature. The millivolt reading corresponding to this temperature is obtained from the chart. The coarse and fine controls are adjusted until this reading is obtained with the selector switch in "thermistor" position. The selector switch is then placed in the "standard" position, and a millivolt reading is taken. This is the standard setting for the particular thermistor–control box combination and is the reference point used to zero the equipment in the field.

Operation of Equipment

Field use of the instrument consists of setting the equipment up on a gate tower or catwalk or in a boat. After the equipment has been standardized, the thermistor holder is lowered to the desired depth. As soon as a steady reading is obtained, the depth and millivolt reading should be recorded on a worksheet. The unit is then lowered to the next depth, and the procedure is repeated. It has been found advantageous to take a complete set of readings during the descent, rechecking at several levels during the ascent. Using this procedure, it is possible for one man to obtain a thermal profile of a 100-ft reservoir in less than 15 min.

It has been found useful to have the cable marked with painted bands at 1-ft intervals, the 5-ft bands in a different color, and wider bands at 25-ft intervals. The Port-O-Reel,* a portable reel with 500-ft capacity, is highly satisfactory for holding the cable. The sliding contacts on the collector rings of these reels make positive contact, allowing the cable to be reeled in or out even during readings if desired.

Since these thermistor units have been in routine use, the Los Angeles Dept. of Water and Power has been able to obtain complete thermal profiles of all major reservoirs. These data are plotted on graphs for each reservoir. By comparing present conditions with those of previous years, it is often possible to predict reservoir conditions, including overturn. This enables the department to change outlet gates and

* A product of Industrial Electrical Works, Omaha, Neb.

to utilize water of optimum quality in the distribution system.

Thermistor units have been used by several other agencies in Southern California. The Los Angeles Harbor Dept. uses one in harbor pollution and circulation studies. One water company has used a thermistor unit in well surveys to determine the feasibility of sealing off warm aquifers in the well casing.

Thermistor equipment is a definite improvement over the former methods of obtaining deep-water temperatures, providing savings in manpower and time with no sacrifice in accuracy.

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Eisenhower on Water and Other Natural Resources

The following excerpt is from the President's State of the Union Message to Congress on Feb. 2, 1953:

Vitally important are the water and minerals, public lands and standing timber, forage, and wildlife of this country. A vast-growing population will have vast future needs in these resources. We must more than match the substantial achievements in the half-century since President Theodore Roosevelt awakened the nation to the problem of conservation.

This calls for a strong federal program in the field of resource development. Its major projects should be timed, wherever possible, to assist in leveling off peaks and valleys in our economic life. Soundly planned projects already initiated should be carried out. New ones will be planned for the future.

The best natural resources program for America will not result from exclusive dependence on federal bureaucracy. It will involve a partnership of the states and local communities, private citizens and the federal government, all working together. This combined effort will advance the development of the great river valleys of our nation and the power that they can generate.

Likewise, such a partnership can be effective in the expansion throughout the nation of upstream storage; the sound use of public lands; the wise conservation of minerals; and the sustained yield of our forests.

There has been much criticism, some of it apparently justified, of the confusion resulting from overlapping federal activities in this entire field of resource conservation. This matter is being exhaustively studied and appropriate reorganization plans will be developed.

Use of Fluoride as a Tracer in Distribution System Studies

By Gilbert V. Levin and Norman E. Jackson

A paper presented on Oct. 30, 1952, at the Chesapeake Section Meeting, Washington, D.C., by Gilbert V. Levin, Public Health Engr., Bureau of Public Health Eng., Dist. of Columbia Health Dept., Washington, D.C., and Norman E. Jackson, Chief, Dalecarlia Section, Washington Aqueduct, Water Supply Div., Washington Dist. Office, U.S. Army Corps of Engrs., Washington, D.C.

WHEN fluoridation of the District of Columbia water supply was begun in 1952, the agencies concerned took the opportunity to determine some important hydraulic characteristics of the headworks and 1,200 miles of distribution system. No other city is known to have used this method, which may prove to have many applications.

When the fluoride was first introduced into the water supply system, a simple chemical test showed the time of arrival of fluoride-bearing water at each of a number of selected points. From these data, information concerning velocities, direction of flow, detention periods, system balance, and other related factors was deduced.

Using as much manpower as the Washington Aqueduct, the water division, the U.S. Public Health Service, and the health department could spare, the participants balanced the number of sampling stations and the frequency of sampling to get the data that would be most useful. Forty-eight stations were picked (Fig. 1–4), at each of which samples were collected at least once during every 4-hour period (called "shift") of the test. Except for the treatment plants and reservoirs, all stations selected were fire hydrants. They afforded 24-hour accessibility, ready parking, sizable flow, and proximity to mains.

To reduce analysis time, a 5-min qualitative test was developed, employing a modification of the zirconium-alizarin method described by Megregian and Maier (*1*). A 5-ml portion of the reagent was mixed rapidly with both the control and test samples of water. After standing 5 min, the test sample would bleach detectably if 0.2 ppm or more fluoride was present. Quantitative determinations of all samples indicating fluorides were made during slack periods.

District of Columbia System

Water for the District of Columbia is diverted from the Potomac River to the Dalecarlia Plant. Approximately one-third of the water is treated completely at that plant. The other two-thirds is treated there with alum and then flows by gravity through the Georgetown Reservoir and across town to the McMillan Plant for final treatment. The various service zones are:

Service Zone	Supplied by
Low	McMillan (by gravity)
1st High	McMillan and Dalecarlia jointly
1st High (Anacostia)	McMillan via booster station on low service
2nd High	McMillan and Dalecarlia jointly
2nd High (Anacostia)	McMillan via booster station on low service
3rd High	Dalecarlia
4th High	Dalecarlia via booster station on 3rd high service

All fluoridation equipment is at the Dalecarlia Plant, and the chemical is added, by separate machines, to the finished water produced there and to the partially treated water being shunted to McMillan. The average water consumption during the test period was 211 mgd.

Procedure

Sampling was begun shortly after the fluoride was injected into the supply at 9:30 AM on June 23, 1952. As soon as fluoride was positively detected in a sample, that station was eliminated from further sampling. Initial fluoride content at the various stations varied from 0.06 to 1.0 ppm. Five stations indicated positive on the qualitative test at fluoride concentrations below 0.2 ppm, which was thought to be the minimum detectable by the test. These stations were resampled on the subsequent sampling round, with the exception of one (No. 31) due to oversight, and the presence of fluoride was verified. Within two weeks all pressure zones showed fluoride in the neighborhood of 1.0 ppm in the regular control samples.

Handling of the data was simplified by consecutively numbering the 4-hour sampling periods, beginning with 8 AM–12 noon of June 23, and using those numbers for plotting and reference (Table 1). The time of the arrival of fluoride at each sampling station was recorded on a large map of the distribution system. After this information had been accumulated, clear-plastic overlays were placed over the map, and the appropriate shift numbers were marked on the overlays at the locations of the stations. These points were then connected on the overlays in chronological order by way of the transmission mains that were thus indicated. Arrows were placed on the routes indicating the direction of flow, except in several small loops where insufficient sampling stations made this deduction unreliable.

Data indicating the time of initial detection of fluoride at the sampling stations are presented in Table 2. This material is chronologically arranged for each of the pressure zones. It should be emphasized that the interpretation of the data obtained is based on the specific pumpages and reservoir levels prevailing during the period of the test, as shown in Table 3. Further attention is directed to the fact that the accuracy of the times of fluoride appearance may be off as much as 4 hours—one sampling shift—except for the intraplant data, for which samples were collected every 2 hours and sometimes hourly. The data, therefore, are not acceptable for any precise mathematical treatment. Certain useful, generally applicable conclusions can, however, be deduced, as will be shown. The value of any increase in precision

TABLE 1—*Sampling Periods and Shift Numbers*

Date	Time	Shift No.
June 23	8–12 AM	1
	12–4 PM	2
	4–8 PM	3
	8–12 PM	4
24	12–4 AM	5
	4–8 AM	6
	8–12 AM	7
	12–4 PM	8
	4–8 PM	9
	8–12 PM	10
25	12–4 AM	11
	4–8 AM	12
	8–12 AM	13
	12–4 PM	14
	4–8 PM	15
	8–12 PM	16
26	12–4 AM	17
	4–8 AM	18
	8–12 AM	19
	12–4 PM	20
	4–8 PM	21
	8–12 PM	22
27	12–4 AM	23
	4–8 AM	24
	8–12 AM	25
	12–4 PM	26
	4–8 PM	27
	8–12 PM	28
28	12–4 AM	29
	4–8 AM	30
	8–12 AM	31
	12–4 PM	32
	4–8 PM	33
	8–12 PM	34
29	12–4 AM	35
	4–8 AM	36
	8–12 AM	37
	12–4 PM	38
	4–8 PM	39
	8–12 PM	40
30	12–4 AM	41
	4–8 AM	42
	8–12 AM	43
	12–4 PM	44
	4–8 PM	45
	8–12 PM	46
July 1	12–4 AM	47
	4–8 AM	48
	8–12 AM	49
	12–4 PM	50
	4–8 PM	51
	8–12 PM	52

of the data is questionable, because any practical application of the results would probably take more than 4 hours (one shift) to apply in the field.

The results for the intraplant system and the various pressure zones are discussed below.

Intraplant System

The intraplant system (Fig. 1) consists of the reservoirs, conduits, and treatment works supplying the distribution system. Using the capacities of the Georgetown and McMillan reservoirs and the flow records through these basins, the theoretical detention times are easily calculated. The ratio of the actual to the theoretical detention time, which might be called the "detention ratio," is a useful index of short-circuiting in a reservoir. Under ideal conditions, not obtainable in practice, the detention ratio for a perfect reservoir would be unity. The determination of the actual detention times by use of the fluoride tracer makes this comparison possible.

There may be some argument on whether the first appearance of a portion of water is truly indicative of the detention time of the slug from which it came. Perhaps an average detention time would be more correct. This could be measured by waiting for the fluoride content of the water to build up to a precalculated level representing the concentration at the average detention time. Use of the first fluoride-positive sample, however, greatly simplifies the field work and in no way hampers the comparability of the detention ratios if this method is employed throughout.

Fluoride ion traversed the Georgetown Reservoir on June 23. On that day approximately 114 mil gal flowed through the reservoir. The capacity of the reservoir at the elevation main-

tained on that day is approximately 160 mil gal. The theoretical detention time is, therefore, approximately $24 \times 160 \div 114 = 33.7$ hours (say 34). The actual detention time, as measured between Stations *A* and *C*, was two shifts, or approximately 8 hours. The detention ratio is 8 : 34, or approximately 0.24, indicating considerable short-circuiting through the reservoir.

At McMillan, the fluoride ion crossed the reservoir on June 24 and 25. On those days the total flow to McMillan was 260 mil gal and the reservoir elevation dropped an amount equivalent to 6.6 mil gal, making the total flow out of the reservoir approximately 267 mil gal. The capacity of the reservoir at the average elevation maintained on those two days is 265 mil gal. One-third of this, however, is at an elevation below the outlet. Owing to stratification, it is believed that this portion constitutes dead stor-

TABLE 2

Initial Appearance of Fluoride

Pressure Zone	Station	Date (June 1952)	Shift No.	Initial F^- Concentration *ppm*
Intra-plant	A	23	1	1.0
	B	23	3	0.36
	C	23	3	0.20
	D	24	5	0.20
	E	25	12	0.26
	F	26	17	0.28
	G	26	21	0.22
Low Service	1	26	21	0.22
	2	26	22	0.30
	10	26	22	0.24
	6	27	23	0.29
	3	27	23	0.30
	7	27	23	0.36
	9	27	23	0.20
	8	27	23	0.24
	4	27	24	0.28
	5	27	24	0.29
	10a	27	27	0.30
1st High Service	12	23	1	0.78
	13	24	6	0.46
	14	24	7	0.68
	19a	24	7	0.60
	11a	26	19	0.31
	11	27	23	0.30
1st High Service Anacostia	17	27	23	0.24
	18a	27	24	0.24
	18	27	25	0.22
	19	27	27	0.28
	17a	28	31	0.42
	15	28	32	0.30
2nd High Service	24	23	4	0.72
	25	23	4	0.48
	22	23	4	0.84
	26	24	5	0.90
	21	24	6	0.24
	23	24	8	0.30
	27	27	24	0.30
	20	28	31	0.32
	28	1*	49	0.50
2nd High Service Anacostia	29	27	23	0.60
	30	27	24	0.16
3rd High Service	37	23	3	0.54
	33	23	4	0.41
	32	24	7	0.28
	36	24	10	0.46
	35	24	10	0.58
	34	24	10	0.29
	38	25	11	0.14
	31	25	12	0.06
	39	28	29	0.22
4th High Service	42	24	5	0.20
	41	24	7	0.28
	43	24	7	0.44
	44	24	7	0.60
	40	25	11	0.35

* July.

age. The theoretical detention time based on total capacity is $48 \times 265 \div 267$, or approximately 48 hours. The actual detention time (Station *D–E*) is seven shifts, or approximately 28 hours. The detention ratio is approximately 28:48, or 0.58. This figure indicates that the detention characteristics of the McMillan Reservoir are considerably better than those of the Georgetown Reservoir. Whether the 0.58 ratio for McMillan should be higher the authors cannot tell, as they have no data to indicate what ratios can actually be obtained in reservoirs.

TABLE 3

Water Demand

Date (June 1952)	Low Service	1st High Service				2nd High Service				3rd & 4th High Services			
		Dalecarlia	McMillan	Reservoir Fluctuation	Total	Dalecarlia	McMillan	Reservoir Fluctuation	Total	Dalecarlia	McMillan	Reservoir Fluctuation	Total
	Water Demand—*mil gal*												
23	66.4	24.6	25.0	−0.4	50.0	10.2	10.9	−1.1	22.2	25.3	11.5	+0.3	36.5
24	70.6	28.2	25.1	0.0	53.3	5.3	20.0	+2.1	23.2	34.5	5.4	−0.2	40.1
25	81.6	28.7	27.6	−6.6	62.9	7.9	19.8	−0.9	28.6	37.3	9.6	+0.2	46.7
26	84.6	43.8	29.2	+7.0	66.0	10.4	20.5	−0.6	31.5	40.4	10.7	−0.5	51.6
27	83.4	36.0	28.4	+0.1	64.3	13.6	16.6	−2.6	32.8	40.4	14.1	+0.6	53.9
28	77.8	29.2	29.2	−0.4	58.8	13.9	18.0	+3.6	28.3	39.2	12.6	+0.6	51.2
Avg	77.4				59.2				27.8				46.7

Low Service

Fluoridated water was first detected in the low service (Fig. 1) during Shift 22, one shift after it was found in the McMillan clear well outlet. During Shift 28, fluoride was established as passing the furthest station in the system, completing its detection at all sampling stations in the system. This had happened in the surprisingly short time of six shifts, approximately 24 hours. The rapid progression of fluoridated water through the system was highlighted by the appearance of fluoride at Station 10, across the Anacostia River, within 4 hours after it had first entered a 4½-mile transmission main at McMillan. Stations 2 and 10 presented an apparent incongruity in the chronology of the test because they both showed fluoride during Shift 22 although all the sampled mains feeding them did not give evidence of fluoride until later shifts. A check of the distribution system map showed a large main having no sampling stations on it. The timing proved that this main was the only one through which the fluoride could have arrived at stations 2 and 10. It was possible to show how water from this main had divided between the two mains sampled by stations 2 and 10. Another division of this type was detected between stations 3, 9, and 7.

1st High Service

A major break in a 36-in. main feeding the 1st High Service (Fig. 2) put

that service out of operation for 6 hours, beginning at 3:15 PM on June 25. A total of 25 mil gal of unfluoridated water drained through the break. This water was replaced with fluoridated water, which may have advanced the arrival of fluoride in the 1st High Service by half a day.

dated water came from the McMillan Plant until Shift 21. It would thus appear that the pressure of 1st High Service water pumped from McMillan was not sufficient to balance that from Dalecarlia in the principal service area of the former. Had it not been for the break in the line, with the subsequent

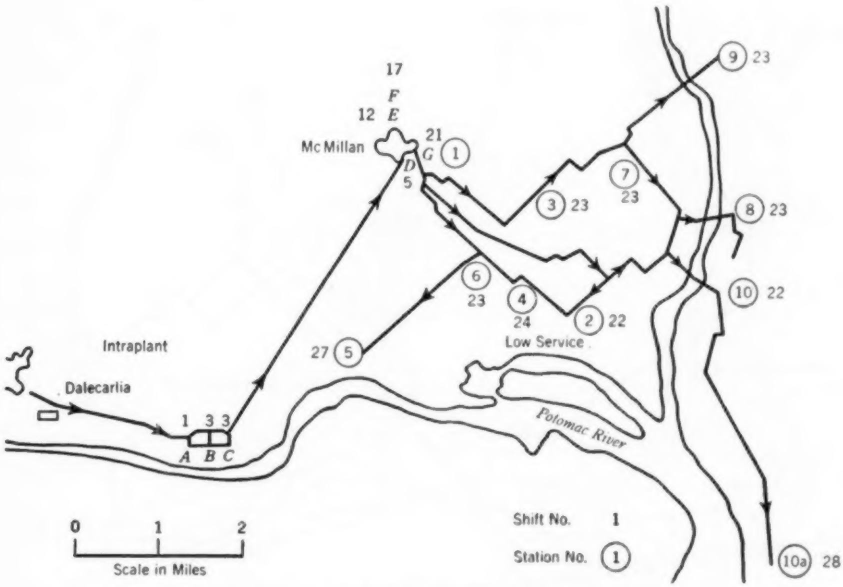

Fig. 1. Intraplant and Low-Service Sampling Stations

Intraplant: A—*Georgetown Reservoir inlet;* B—*midpoint in Georgetown Reservoir;* C—*Georgetown Reservoir outlet;* D—*McMillan Reservoir inlet;* E—*McMillan Reservoir outlet;* F—*McMillan clear well inlet;* G—*McMillan clear well outlet. Low service (circled numbers): 1—McMillan clear well; other stations are hydrants at various points on distribution system. Uncircled numbers represent shifts (see Table 1).*

All the fluoridated water detected in this service came from the Dalecarlia Plant, although the McMillan Plant also pumps to this service. This statement is borne out by the fact that fluorides were detected at all sampling stations on the distribution system itself by Shift 7 even though no fluori-

rapid refilling of the mains with fluoridated water from Dalecarlia, these data would have led to the conclusion that Dalecarlia was doing the lion's share of work in the 1st High Service. Whether or not this tendency would have prevailed under normal operation is not known.

Fluoridated water passed the 1st High-Service Reservoir, which floats on the system, sometime before Shift 4. Not until Shift 19, however, was fluoride detected at the inlet, and fluoridated water was not returned to the system from the reservoir until Shift 23. (Flap gates and a baffle wall provide a separate inlet and outlet although the reservoir floats.) It can thus be seen that water entering the reservoir was detained nineteen shifts, or approximately 76 hours. This reservoir has had an occasional history of poor bacteriological samples due to seepage through the slab roof during periods of heavy rain. It is doubtful whether any chlorine residual would be retained after 76 hours, which may account for the sporadic coliform-positive samples.

1st High Anacostia Service

During the test period water flowed from the pumps through the 1st High Anacostia Service (Fig. 3) to all sampling stations in an orderly fashion within eight shifts.

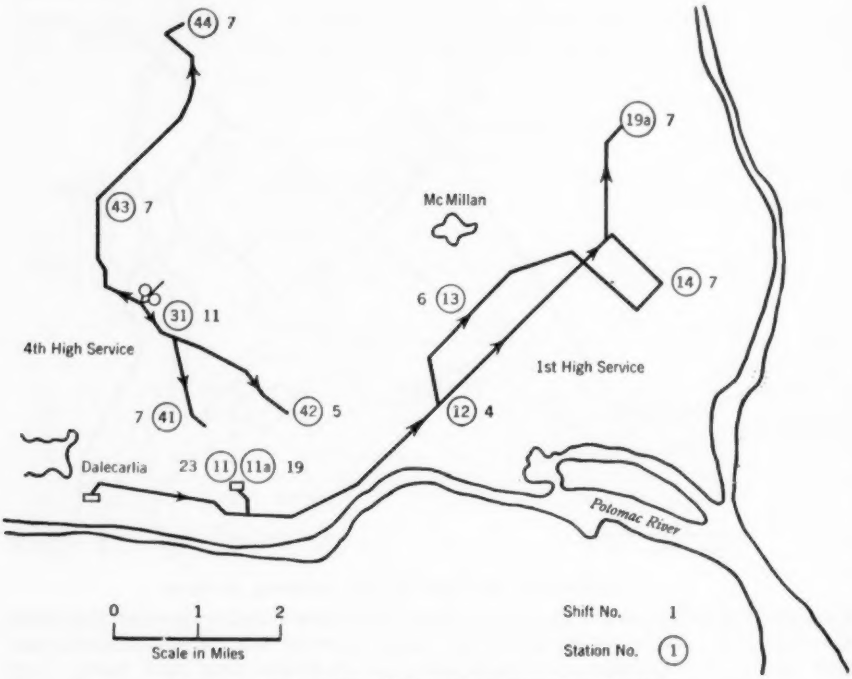

Fig. 2. 1st and 4th High-Service Sampling Stations

Circled numbers: 11—1st High-Service Reservoir outlet; 11a—1st High-Service Reservoir inlet; other stations are hydrants at various points on distribution system. Uncircled numbers represent shifts (see Table 1).

2nd High Service

In the 2nd High Service (Fig. 3), examination of the data reveals that by

Shift 8 fluoridated water had progressed through all the distribution mains sampled west of McMillan, the Dalecarlia side. This water must have come from Dalecarlia as McMillan produced no fluoridated water until Shift 21. No fluorides were detected in water from stations east of McMillan until Shift 24. It may be safely concluded that a pressure balance existed in the system just east of McMillan, and Dalecarlia water did not flow past this balancing line. This condition divides about equally the service area supplied by each plant. Records show that McMillan pumped considerably more water during the test period than did Dalecarlia, indicating a difference in consumption characteristics in the two areas.

Fluoride was not detected in the 2nd High-Service Reservoir, which floats on the system, until Shift 31, although it was found in the main floating the reservoir at a considerable distance past it during Shift 4. It can readily be deduced that new water did not enter the reservoir for a minimum of 27 shifts, approximately 4½ days. This information should be considered in connection with the fact that poor bacteriological samples have been obtained

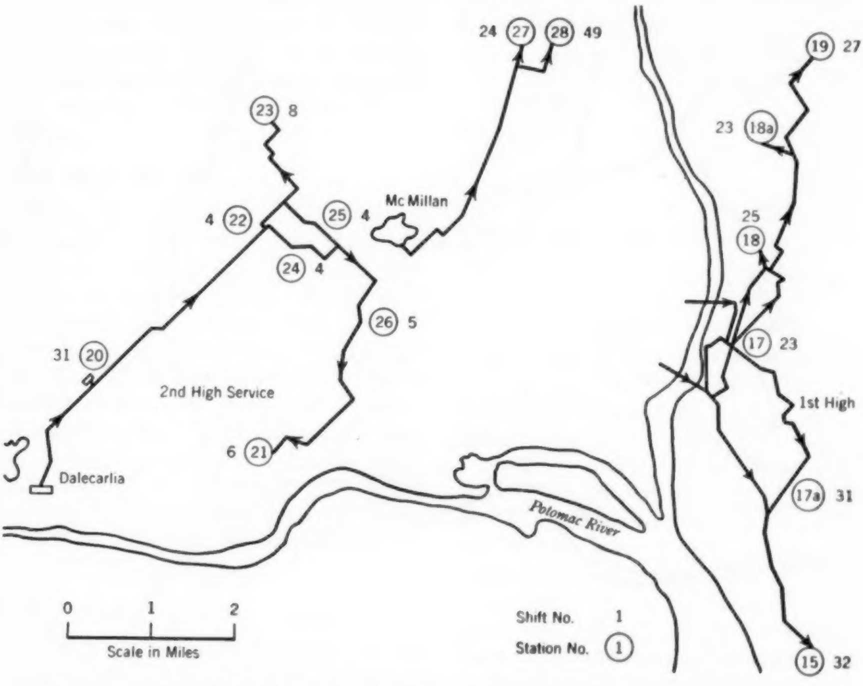

Fig. 3. 2nd High-Service and 1st High Anacostia Service Sampling Stations
Circled numbers: 20—2nd High-Service Reservoir (instrument house); other stations are hydrants at various points on distribution system. Uncircled numbers represent shifts (see Table 1).

from this reservoir (more frequently than from the 1st High-Service Reservoir).

An interesting sidelight for investigation is the fact that, although fluoridated water reached Station 27 during Shift 24, it did not reach nearby Station 28 until Shift 49. Station 27 is on a large main which also supplies a smaller main to Station 28. A very light demand in the main sampled by Station 28 or a partially blocked line might account for the large difference in time.

2nd High Anacostia Service

Only two sampling stations were selected in the relatively small 2nd High Anacostia Service area (Fig. 4). Fluoridated water reached the first station during Shift 23 and proceeded to the second station, where it arrived during Shift 24.

3rd High Service

Stations 32 and 37 on the 3rd High Service (Fig. 4) are connected by a fairly new 36-in. main, which was the expected route of flow. The test showed, however, that a longer, older, and more circuitous route (as shown on map) was actually pursued. The data were carefully examined and found to be reliable. A water department employee familiar with that section of the distribution system sug-

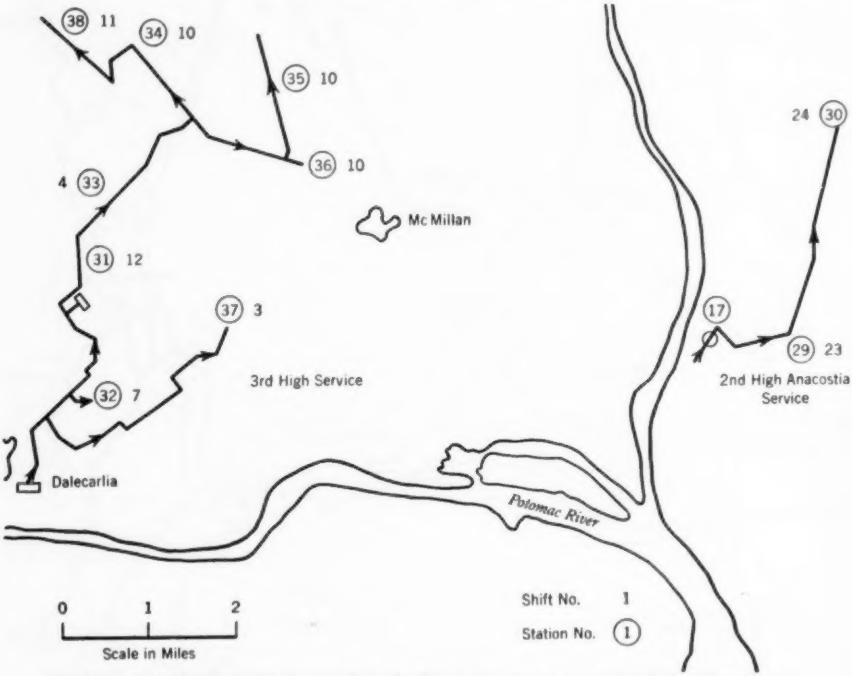

Fig. 4. 3rd High-Service and 2nd High Anacostia Service Sampling Stations
Circled numbers: 31—3rd High-Service Reservoir; other stations are hydrants at various points on distribution system. Uncircled numbers represent shifts (see Table 1).

gested that the 36-in. main might be partially obstructed, but as of October 1952 no field investigation had been made because of the heavy schedule of the work crews.

It was found that the 3rd High-Service Reservoir received fluoridated water during Shift 12. Station 33, on the main supplying the reservoir, and a considerable distance past it, showed fluoride during Shift 4. It is thus indicated that fluoridated water bypassed the reservoir for more than seven shifts.

4th High Service

The 4th High Service (Fig. 2) is pumped directly from the 3rd High Service, although storage is also provided in towers. Thus, fluoride did not reach this system until Shift 5, one shift after fluoridated 3rd High Service water had passed the pumping station. The 4th High Service water progressed both north and south from the pumping station in an orderly fashion, making its appearance at the final distribution system station during Shift 7. Fluoride was detected in the towers during Shift 11.

General Applications

The most important result of the tests was the establishment of reasonably well-defined times of travel in the system. Although the data presented pertain to specific demand conditions in the system, a simple application of the law of continuous flow makes possible the determination of approximate arrival times or velocities for, or between, any points originally trace-sampled in a distribution system.

In the equation:

$$Q = AV = \frac{Ad}{t}$$

Q is the average water demand on the pressure zone during the time of test; A is the equivalent cross-section area of the pipes from the plant to the point under study; V is the average velocity of the water flowing from the plant to the point under study, as determined by the trace test; and d is the distance traveled by the water in time t, as determined by the trace test. If A and d are constant $(Ad = k)$, then:

$$Q = \frac{k}{t}$$

or:

$$t \sim \frac{1}{Q}$$

Then to find t_1 for any Q_1:

$$t_1 = \frac{tQ}{Q_1}$$

Time of travel may also be calculated between any two points by finding the difference between the respective t values.

Factors which may render this analysis invalid, by varying A and d, are: [1] any major physical change in the distribution system which will either provide a new route to the point under study or will replace pipe in the route with pipe of a diameter different from the original; [2] a major change in the operating level of the reservoir; or [3] a major change in demand characteristics of the system. None of these factors is likely to invalidate the original data for some time, as such changes do not occur rapidly in a system.

By use of the tracer method, a chart showing water travel times to all critical points for varying demands can be prepared. In the event of a major break, sabotage by poisoning, or bombing at any point in the system, the chart would readily indicate the areas that would be affected at any time.

Estimating the time required to get to the valve locations, the operator could determine which valves should be closed to limit the effects of the incident.

The determination of actual detention times in reservoirs and settling basins by the tracer method provides easily obtained, useful information. In addition to detention time, the actual velocity of the water may be established by cross-section sampling at various points in the basin. This information can be applied to the design of new basins or improvements in existing ones not functioning properly.

Areas of influence and the effects on a system of its various pumping stations can also be deduced from the tracer data. As has been shown in this paper, the actual balancing condition between pumping stations can be found. Such information can be used to increase the operating efficiency of a water supply system by obtaining optimum pumping schedules for the various stations.

Used simultaneously with flowmeter tests, the tracer test can establish actual times of travel for measured flows in any given main or mains. Accurate information on pipeline characteristics, including roughness coefficients, can thus be obtained.

A program to trace the progress of fluoride ion through a water treatment plant and distribution network offers many real advantages. The results of such a practical, empirical study can be applied to the design, construction, and operation of the system. Although the beginning of fluoridation in a water supply system is an excellent time to make such a study, it may be possible to use other harmless, odorless, and tasteless elements easily detectable in trace quantities, such as chlorides, nitrates, or minute concentrations of short half-life radioisotopes. The method may be made as precise as desired or as time and personnel permit.

Acknowledgment

The authors are particularly indebted to the following men for their aid in executing this program: Thomas M. Latimer, Assoc. Engr., District of Columbia Water Dept.; Stephen Megregian, Sanitarian (R), U.S. Public Health Service; and W. S. Sitler, Regional Water Supply Consultant, U.S. Public Health Service.

Reference

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Fluoridation Planning and Operating Experience

A Symposium

A selection of papers on fluoridation presented at various recent section meetings.

District of Columbia—*Norman E. Jackson*

A paper presented on Oct. 30, 1952, at the Chesapeake Section Meeting, Washington, D.C., by Norman E. Jackson, Chief, Dalecarlia Section, Washington Aqueduct, Water Supply Div., Washington Dist. Office, U.S. Army Corps of Engrs., Washington, D.C.

IN April 1951, prior to the commencement of fluoridation of the District of Columbia water supply, studies to determine how fluoridation could best be accomplished were begun by the Washington Aqueduct, with the Water Supply Div. of the Washington District, Corps of Engineers, U.S. Army, as the responsible agent. These studies culminated in a report which was issued in July 1951. The report was based on two premises: [1] that the best plan was one which provided a complete and adequate fluoridation installation within the shortest time and with the least expense; and [2] that if, after a few years of experience, it were decided to discontinue or change the fluoridation process, the plan adopted should make it possible to do so with minimum loss of investment. In order to implement these underlying principles, the utilization of existing space and equipment insofar as practicable was the guiding thought behind the planning report. A brief account of some of the problems which had to be faced may be of interest.

Source of Fluorine

One of the first decisions that had to be reached was what source of fluoride ion to use. After a thorough study of the three leading chemicals available commercially and approved by the U.S. Public Health Service—sodium fluoride (NaF), sodium silicofluoride (Na_2SiF_6) and hydrofluosilicic acid (H_2SiF_6)—it was decided to use the dry powder form of sodium silicofluoride, chiefly because: [1] available space and existing plant facilities and handling methods made it the most advantageous; [2] it appeared to be the most reliable source of fluoride ion available; and [3] it was the cheapest source for a large installation.

The first contract for sodium silicofluoride was let in November 1951, for $7.65 per hundredweight, delivered at the plant by rail from Tampa, Fla. A second contract was executed in October 1952, for $6.00 per hundredweight, delivered at the plant by truck from Baltimore, Md. An allowance is received on empty drums returned to the manufacturer.

Location of Installation

District of Columbia water is treated at two filter plants, Dalecarlia and McMillan, but the raw-water conduit for McMillan passes within 300 ft of the Dalecarlia Plant. Instead of a

separate fluoridation installation at each plant, a single installation, with two feeders, at Dalecarlia could supply fluorine to the filtered Dalecarlia and raw McMillan water. It was necessary to ascertain, however, whether there would be a prohibitive loss of solution would be introduced had a definite bearing on this question. If there was a loss in fluorine, in what degree would it be and how would the cost of this loss compare with the cost of building a separate installation at McMillan?

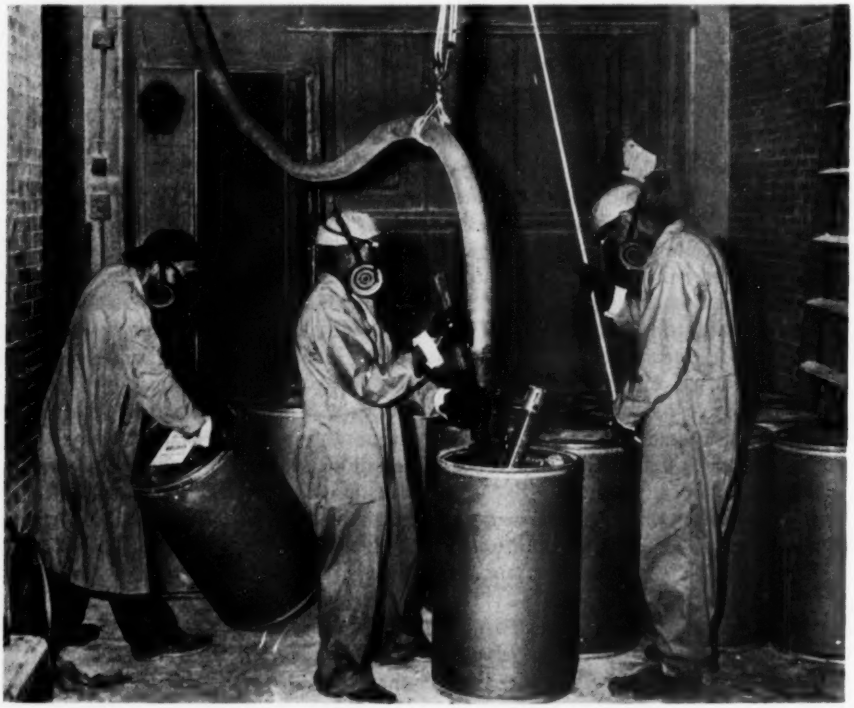

Fig. 1. Handling Sodium Silicofluoride

The suction tube of the pneumatic conveyor is in place in a drum of sodium silicofluoride. Note the protective gear worn by the workmen.

fluorine in the raw water during its passage through two large open sedimentation and storage reservoirs, a crosstown tunnel, and the slow sand filters of the McMillan Plant. The application of alum to the McMillan raw-water supply at a point immediately below the spot where the fluoride

Past experience of other pioneers in fluoridation indicated that there was little fluorine demand in reservoirs, pipelines, and basins. Consequently, it was felt that fluorine depletion through flocculation and sedimentation would be the greater part of any loss sustained. The Dalecarlia laboratory was

called upon to estimate the extent to which fluorine would be adsorbed in alum flocculation.

There was not time enough for exhaustive research, but sufficient data were gathered to indicate that, at an average alum dosage of approximately 19 ppm (based on 17 per cent Al_2O_3), only a 7–10 per cent loss of fluorine would be experienced. At higher doses, 47–50 ppm, of alum, as much as 25–30 per cent of fluorine could be expected to be carried down with the alum floc, but these high dosages occurred infrequently. In the light of this information, the single installation under one roof at Dalecarlia for fluoridating both sources of water appeared preferable, certainly for a temporary installation and probably for a permanent one. Brief experience with floc adsorption since the start of fluoridation indicates little change from the laboratory figures.

Packaging

Although there is a railroad siding available at the Dalecarlia Plant, Interstate Commerce Commission rulings on shipments in bulk were not fully clarified. Therefore, the choice was limited to 100-lb bags or 125- or 350–400-lb drums. Because of the large quantities needed to meet Washington's water demand and because of the possibility of bag breakage with an attendant toxic-dust hazard, it was decided to purchase sodium silicofluoride in 350-lb drums in carloads or trailer truckloads.

Conveying

The drums were to be opened in the scale house of the main building and the chemical raised vertically by vacuum pneumatic equipment (Fig. 1 and 2) to a concrete storage bin of 125-ton capacity in the tower of the building. The handling equipment would remove the finer dust particles through bag filters and would dump the material into the storage bin. The fact that the nozzle of the pneumatic equipment would always be under vacuum when placed in a drum would greatly cut down the toxic-dust hazard to the workmen.

For further protection of the workmen, it was planned to supply them with cotton coveralls which could be laundered, rubber-impregnated fabric gloves, a suitable respirator with a large breathing area, full-view goggles which might be worn over glasses, and a cotton skullcap for a head covering.

Arching and Caking

Sodium silicofluoride is not considered to be hygroscopic, but, because little was known of its arching properties, a 60-deg sloped false wooden bottom and air slides were installed to prevent arching and induce a smooth flow of material to the feeder hoppers. As a precaution against caking of the chemical under heavy loading pressure, only 20–30 tons was to be stored in the 125-ton bin. Experience since the start of fluoridation has indicated that even this amount is too great, for the material began to lump in approximately one month. This condition caused an uneven application through the feeder and thus a nonuniform flow of materials to the solution tanks. The difficulty appears to be due chiefly to weight and to the length of the detention period. Since the amount of storage was reduced to 10–15 tons and the flow-through time decreased to 6–8 days, the lumping has ceased, and the machines are now feeding uniformly. Hygroscopic action was not a factor,

as analysis showed less than 0.05 per cent moisture.

Feeding Equipment

After consultation with representatives and engineers of the leading dry-feed equipment manufacturers, it was determined that a gravimetric feeder would be the most desirable. Antiflood gates were required to be placed between the hoppers and the feeder in order to prevent flooding and overfeeding to the water supply. Also specified were dust collectors, to prevent the escape of dust to the surrounding air when the machine hoppers were being filled, as well as dustproofing of the cabinet enclosing the machine. The accuracy of feeding was to be within 0.5–1 per cent, and alarms,

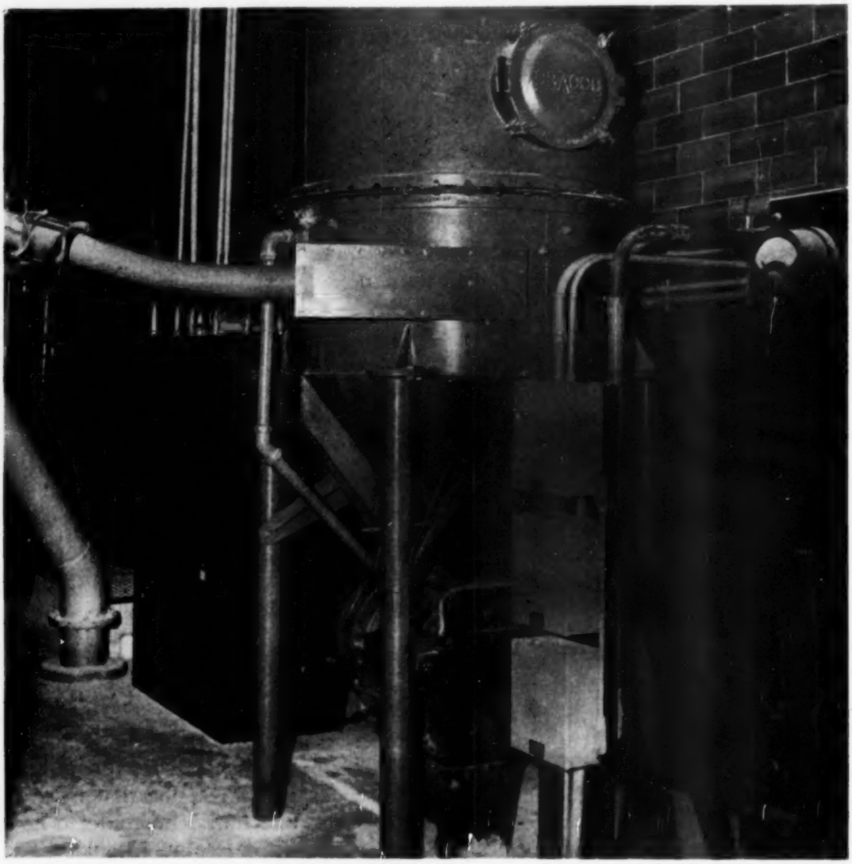

Fig. 2. Pneumatic Conveyor

The cyclone separator of the pneumatic conveyor is shown. The chemical drops by gravity through the gate at the bottom into the concrete storage bin below. Lighter dusts are separated through bag filters at the top.

both visual and audible, had to be furnished in order to prevent over- and underfeeding and insure the desired 1 ppm of fluoride. Indicators for both the upper and lower levels of sodium silicofluoride in the feeder hoppers were included in the feeding equipment. A rate-of-feed dial, graduated in millions of gallons per day on one scale and in pounds per day on another (based on 14 lb of sodium silicofluoride per 1 mil gal of water), was also a requirement. Overall dusttightness was another basic need that had to be met.

The accuracy of the machine installed is satisfactory, but there remain some adjustments to be made on the dust-collecting system to insure efficient dust removal from the feeder hoppers and solution tanks where the chemical drops into the solution water. Further dustproofing of the feeder housing and flexible connections will also be necessary. The corrosion of metal parts within the feeder housing, both in contact with the chemical and remote from it, indicates the need for special metals or materials to resist this action. When these corrections have been made, the machine will meet the requirements satisfactorily.

Solution Tanks

The design of the solution tanks was based on the solubility of sodium silicofluoride over a solution water temperature range of 34°–80°F, with a minimum detention time of approximately 15 min in the solution tank. (As heated water is not used, a longer minimum detention period is necessary.) Using this figure and assuming an average water demand of 71 and 105 mgd from Dalecarlia and McMillan, respectively, the volume determined for each tank was 500 gal. The tanks were made the same size to assure easier fabrication and erection and to provide for overloading at each plant.

After much study of all types of materials, it was decided to use a polythene lining on the steel tanks. It is readily and uniformly applied to steel and offers excellent resistance to the corrosive action of a solution having a pH of 2–4.

Piping

Some of the advantages of plastic polythene pipe had been noted in 1950, when it was used for water-sampling lines. It is flexible, corrosion proof, and has good properties for handling chemicals. Although plastic pipe has a low bursting pressure (approximately 165 psi in the 3-in. size), the planned fluoridation line would be under only a slight pressure.

In the beginning the Dalecarlia solution line system was designed with rigid piping, but it was found that plastic piping could not then be supplied in rigid lengths of the 3-in. size needed. Nor were fittings available in the varieties and sizes required. Flexible plastic piping would serve, but there was a definite need for on-the-job fabrication for making connections, sharp bends, offsets, and the like. Information on welding plastic pipe was obtained from a manufacturer, and the difficulties of handling the material were then cleared up.

In the final layout, it was decided to come from the solution tanks with rubber-lined steel elbows for strength; then follows a short length of hard-rubber pipe and fittings which passes through the floor; the rest of the piping is of flexible plastic. For more uniform distribution, rubber-lined diffusers were used to terminate the solution lines at the point where the solution enters the water to be fluoridated.

For the McMillan solution line, it was more advantageous to use an existing 5-in. rubber-lined steel pipe and diffuser, employed for intermittent prechlorination of McMillan raw water, until it could be determined whether the fluoridation of McMillan water at Dalecarlia would be economically justified.

The rubber lining was suitable for a fluoride solution, and, as fluorine and chlorine are both halogens, no chemical reaction between them was anticipated. Laboratory tests were made for confirmation. The only remaining question was whether the hydraulics of the existing piping system might not permit back pressures on the chlorinating machines if both solutions had to be fed at once. Hydraulic analysis indicated that no trouble need be expected from this source, and, accordingly, it was decided to use the line. Tests made since fluoridation has begun have proved that the line performs hydraulically in the manner expected. Only future investigations will be able to determine the effects on rubber-lined pipe of feeding chlorine and fluorine solutions together.

Costs

On June 23, 1952, fluoridation of the Washington water supply in the amount of 1 ppm officially began. As of October 1952, the Washington installation was the largest in the country. Except for short stoppages for machine adjustments and minor repairs, there has been no interruption of this program since its inception.

The installation as erected follows very closely the planning of the original fluoridation report. Congress appropriated $130,000 to build the installation and operate it for part of the first year. The installation and equipment costs amounted to approximately $94,000. The cost of the fluoridation program, based on expenditures thus far, is approximately 10 cents per capita per year. This figure does not include a space cost allocation but does include installation, depreciation, and operating costs. Of this amount, approximately 6 cents is for chemicals.

Washington Suburban Sanitary District—*Louis M. Euler*

A paper presented on Oct. 30, 1952, at the Chesapeake Section Meeting, Washington, D.C., by Louis M. Euler, Engr. of Water Supply, Washington Suburban Sanitary Com., Hyattsville, Md.

Fluoridation of the water supplied by the Washington Suburban Sanitary Commission was started on Dec. 28, 1951. A report had been prepared during the previous year on the comparative cost and availability of fluoride compounds and the cost of feeding equipment and installation. The data collected showed that sodium silicofluoride was the most economical of the fluoride compounds, and it was, therefore, selected for use by the commission. As of October 1952 it was being purchased at 7.75 cents per pound, delivered in 125-lb barrels. This price was for a contract lot of 75 tons.

The sodium silicofluoride compound contains 60 per cent fluoride ion, according to laboratory tests. At an average dosage of 0.95 ppm, the district uses an average of 380 lb per day. Based upon an estimated population of 325,000, the cost per person per

day is 0.009 cents. A 1-ppm fluoride content is maintained in the water.

The district is served from two filtration plants, the Robert B. Morse Plant, near Four Corners, Silver Spring, Md., and the Patuxent Plant, 2 miles west of Laurel, Md. Two independent fluoride installations were therefore required. Both plants are equipped with loss-of-weight feeders having built-in alarm devices to indicate over- or underfeeding. The solution pots are of 40-gal capacity, using 7–8 gpm. Agitators in the solution pots are operated by the solution water entering the pot.

At the Patuxent Plant, the complete fluoridation installation is in a room partitioned off from other equipment. It consists of a filling hopper equipped with a dust collector, enclosed continuous-flow elevator conveyor, storage bin, and feeder. The conveyor elevates the chemical to either the storage bin or the feeder. The bin is filled once or twice a week to minimize the actual handling of the chemical, and the feeder is filled daily as needed from the storage bin. The cost of the installation, including a metal and glass room partition, was $8,590.

At the Robert B. Morse Plant installation, the storage bin and filling hopper are on the floor above the feeder, so that no elevating equipment is necessary. The feeder receives the chemical from storage through a rotary filler which releases the chemical slowly and prevents overfilling. The feeder and filling hopper are completely enclosed in separate rooms constructed of wood and glass partitions. The cost of this installation was $5,425.

The Patuxent Plant consists of two separate filter units of six filters each, having a combined capacity of 31.7 mgd based on a filter rate of 3 gpm per square foot. The point of fluoride application is in the filter unit effluent line, ahead of the clear well. As there are two effluent lines, the solution must be applied at two points. The solution from the feeder is passed through a splitting box which divides it into two solution lines, one for each filter unit. The units are operated at equal rates, so that an equal division of the solution causes proper proportioning of the fluoride.

The feeder is on the third floor of the head house. The solution is carried in threaded plastic pipe in the feeder room, where it is exposed to view. The portions of the line which are undergound are of rubber hose.

Originally the fluoride was applied to the filter influent, in order to utilize an existing solution line. This method was not successful because of the loss of 0.2–0.3 ppm fluoride through the filters.

The Robert B. Morse Plant, although somewhat different in layout from the Patuxent Plant, also consists of two filter units, with a capacity of 10 mgd based on a filter rate of 2 gpm per square foot. Consequently, this plant, too, requires a split feed of the fluoride solution. The points af application of the solution are past the clear well, just ahead of the high-lift pump suction header. This point of application was chosen to make use of an existing sodium bisulfite solution splitting box and the two solution lines. The sodium silicofluoride solution is discharged from the feeder into the splitting box along with the sodium bisulfite solution, and the combined solutions are carried in the common lines to the points of application. Neither the sodium silicofluoride nor the sodium bisulfite (a dechlorinating agent) has any detrimental effect upon

the other. The use of these existing facilities not only saved money, but also eliminated the need for installing facilities in a very limited space.

Fluoride determinations are made each weekday using a colorimetric disk comparator. Owing to a slight variation in color intensities in the 1.0-ppm region of the disk, readings of this order are difficult. Color differences in the region of 0.5 ppm being much easier to distinguish, samples are diluted 50 per cent with fluoride-free water and the observed reading is doubled to get the actual fluoride content. Determinations are made on the previous day's composite of each plant tap and also on a random sample taken the day the tests are made. Samples are also collected and tested daily from points throughout the distribution system. Results of these tests indicate that there is no loss of fluoride in the distribution system.

Hagerstown, Md.—*Richard C. Willson*

A paper presented on Oct. 30, 1952, at the Chesapeake Section Meeting, Washington, D.C., by Richard C. Willson, Supt., Water Dept., Hagerstown, Md.

The question of fluoridating the public water supply of Hagerstown, Md., was first formally considered by the Washington County Dental Society in November 1950. Fostered by that group, the program was authorized by the city council in January 1951, but an appropriation for the purchase of equipment and chemicals was not made until June 1951. The installation of equipment was completed, a permit was granted by the Maryland Dept. of Health, and fluoridation was started on Nov. 20, 1951.

The Hagerstown water supply is obtained from mountain springs east of the city and from the Potomac River to the southwest, these two sources being approximately 17 miles apart. It is, therefore, necessary to fluoridate the water from these sources separately, and two units of the same type were purchased.

Fluoridation Installations

The volumetric fluoridating equipment selected has a range of feed from 0.01 to 1.2 cu ft of solid per hour. The rate of feed can be adjusted over a range of 40 to 1 merely by changing a manual control, and, by varying the pulley combination, the feed range may be extended to 120 to 1. The feeder is driven by a 0.17-hp enclosed motor using 115-v, single-phase, 60-cycle alternating current.

The feed mechanism is a horizontal-screw type, utilizing a combination of rotary and axial movement through a feed trough and discharging the chemical at both ends. With this design, flooding or free flow of the chemical is prevented.

The chemical hopper has a capacity of 4 cu ft. Oscillating diaphragms, driven by the main drive motor and operating alternately, agitate the chemical to prevent caking or arching. The hopper is suspended on a built-in scale so that manual checking of the loss of weight may be made regularly. The equipment used at Hagerstown is not fitted with loss-of-weight recorders.

The feeder is equipped with a 40-gal dissolving chamber, which is located directly beneath the feed mechanism.

The water-driven rotating agitator in this chamber promotes mixing and dissolving of the chemical. A stilling well has been placed at the outlet of the dissolving chamber, and the water inlet is equipped with a pressure-reducing valve.

The entire feeder is housed in a dusttight case. Access doors are provided on each end of the equipment. The overall height of the feeder is $59\frac{1}{4}$ in., the width is 24 in., and the depth is $36\frac{1}{4}$ in.

Each installation is supplemented by a dust collector encased in an airtight housing. The bag type collector is equipped with an exhaust fan having a paddle wheel rotor and a capacity of 200 cfm of air. The discharge from the dust collector is piped to the exterior of the building. Masks and gloves have been provided for the operators to use when filling the hoppers.

The treatment point for the mountain source of supply is along the transmission main. As there is a head of 75 ft at that point, it was necessary to install a pump to force the fluoride solution into the main. This pump is driven by a 3-hp, three-phase, 220-v motor and has a capacity of 20 gpm at a head of 160 ft. At the Potomac River plant, the dissolving chamber discharges by gravity into the clear well. The solution is carried through $1\frac{1}{2}$-in. rubber hose.

At the request of the Maryland Dept. of Health, meters have been installed to measure the quantity of water entering the dissolving chamber. Daily readings are reported weekly to the health department to show that sufficient water is being used in the operation to effect solution of the relatively insoluble fluoride salts.

Each installation is equipped with a vacuum breaker to prevent the backsiphonage of fluoride solution from the dissolving chamber into the piping if the pressure in the plant should drop to zero.

The total cost of both installations was approximately $4,100.

The chemical used in the Hagerstown system is sodium silicofluoride, selected because it supplies more fluoride ion per dollar at current market prices than any other compound. Sodium fluoride, although more widely used, costs more per pound and contains 25 per cent less fluoride ion than sodium silicofluoride. Sodium fluoride has an advantage in solubility, but, with the equipment in use at Hagerstown, no difficulty has been encountered in dissolving the silicofluoride.

Trouble due to arching of the chemical in the hopper has been experienced, particularly at the Potomac River plant, but, because the same type of equipment is installed at both treatment points and the chemical supply for both was obtained at the same time, this trouble is ascribed to differences in the climatic conditions in the buildings where the chemical is stored and used. The heat produced by a 100-w lamp installed in each feeder has, on many days, been sufficient to change the physical properties of the chemical so that arching does not occur.

Costs of Program

As the waters to be treated contain 0.3–0.4 ppm of natural fluoride, it is necessary to supplement this with only 0.7 ppm of fluoride ion to reach the optimum recommended by the American Dental Assn. This requires an average of 12 lb of sodium silicofluoride per 1 mil gal of water.

In August 1951 Hagerstown purchased approximately a year's supply

of sodium silicofluoride at a cost of 6.69 cents per pound delivered to Williamsport, Md. In August 1952 inquiries were again sent to eight distributors of this salt, and 30,000 lb was purchased at 6.25 cents per pound. The imported product was offered at that time at 6.10 cents.

No labor is charged to fluoridation, because the regular operators fill the chemical hoppers once a day and periodically check the operation of the feeders. Disregarding the amortization of the feeder cost, the cost of the fluoridation program is the cost of the chemical, power, and a slight increase in the lime dosage. The Hagerstown water works serves an estimated 47,000 consumers, and the average cost for the fluoridation program is 4.04 cents per capita per year. If the $4,100 investment is amortized over 20 years, the cost of the program is 4.62 cents per capita per year.

The expense of executing the fluoridation program at Hagerstown is borne by the water department. In view of the reported benefits attending such programs, the department will continue to assume the costs as a contribution to the well-being of future generations in the community.

Fort Mill, S.C.—*J. D. Lesslie*

A paper presented on Mar. 25, 1952, at the Southeastern Section Meeting, Augusta, Ga., by J. D. Lesslie, Supt., Filter Plants, The Springs Cotton Mills, Fort Mill, S.C.

Fort Mill, S.C., is supplied with water by a 1.5-mgd plant owned and operated by The Springs Cotton Mills. The source of water is the Catawba River, on which the pumping station is located, approximately 3 miles from the filter plant. The plant has two filters, each with a capacity of 750,000 gpd, consisting of sand and gravel with cast-iron manifold and lateral underdrains. A 30-min mixing period is provided by a baffled mixing and coagulating chamber. Mixing is followed by 6 hours' sedimentation prior to filtering. The filters discharge into a 20,000-gal pump suction well, which is connected to a 2-mil gal storage reservoir. The treatment consists of combined residual chlorination, coagulation with alum and soda ash (with occasional use of sodium aluminate), fluoridation, sedimentation, filtration, pH correction with soda ash, corrosion control with metaphosphate, and additional chlorination in the clear-water storage reservoir. Water is metered to the town of Fort Mill. The total population served is approximately 5,000.

Installation

In 1951 the company obtained permission to fluoridate the Fort Mill water supply from the South Carolina Board of Health after it had received the written endorsement of the local Lions Club and the mayor and town council, and the consent of all the local physicians and dentists. The first question to be decided was what chemical to use as a source of fluoride ion. In the light of the experience of Charlotte, N.C., with sodium silicofluoride, that chemical was chosen. The next consideration was the type of dry chemical feeder to buy. Several makes

of machines were studied and quotations received from the manufacturers. Safety, not price, was the principal criterion, however. Because the water plant is privately owned, the risk of liability might be greater than for a municipal water department. Consequently, it was decided to purchase a machine having the greatest factor of safety, the most foolproof operation, and a means of producing a record of the feed. The machine adopted is of the gravimetric, loss-of-weight type and is equipped with an antiflood device and a dust filter.

Next to be considered was the location of the feeder and the point of application. It was decided to install the feeder on the floor of the room in which the other dry feeders are located. A small room $6\frac{1}{2} \times 7\frac{1}{2}$ ft was enclosed with glass windows and glass panes in the door so that the operator would have an unobstructed view of the machine from the laboratory and filter floor. This enclosure is sufficiently large to accommodate the fluoridating machine and ten 100-lb bags of chemical. In this way, the entire stock of silicofluoride is kept in a room separate from the other chemicals. The point of application most convenient to use was the pump suction well located beneath the pumproom floor and directly below the feeder. The solution line from the solution box to the point of application is a 2-in. plastic pipe, which is proving very satisfactory.

The feeder was placed in operation on May 1, 1951. On hand for the occasion were two representatives of the state board of health, the mayor of Fort Mill, the physicians and dentists available at the time, and the local mill officials. The oldest physician in town was selected to start the machine. Publicity was given the innovation by the local newspapers.

For the first two weeks the machine fed soda ash, a fact which was not revealed to those present or to the public. At the end of this period the soda ash was replaced by sodium silicofluoride, with no further publicity. There was no unfavorable reaction by the consumers to either the soda ash or the fluoride treatment. The only note of complaint received read: "Dear Sir: The stuff you are putting in the water is ruining my kitchen sink. It has already dissolved my false teeth. Can't you do something about it?—*A Friend.*"

During the first 4 days of operation, tests were made for fluorides every 30 min, using the Scott-Sanchis method. Samples were collected from the distribution system near the outlet side of the pump taking suction from the pump suction well. Tests were also made on samples from various other parts of the distribution system. The dosage to be maintained was 1 ppm. After the first 4 days samples were collected at hourly intervals. This program was continued until Oct. 1, 1951, at which time sampling was reduced to one every 2 hours, exclusive of distribution samples collected daily. No drop in concentration has been detected between the pump discharge and the end of the distribution system.

Fluoride Feeding

For the first month or two the results of the tests gave some concern. The tests showed variations in concentration from a low of 0.7 ppm to a high of 1.4 ppm. This was not considered sufficiently uniform for accurate dosing, even though the average of the tests and the weight of chemical

applied in 24 hours came within 0.1 ppm of the dosage desired. A fluctuation in feed, perhaps due to cyclic action, or in diffusion in the pump suction well was indicated. Steps were taken to eliminate both possible causes. The manufacturer was requested to furnish a beam counterpoise (with change gears) having one-half the weight of the one originally supplied with the machine. This reduced the effective loading capacity of the hopper from 500 to 250 lb. The change caused the counterpoise to traverse the length of the scale beam in half the time originally required. In this way, the peaks and troughs of the curves produced by cycling might be leveled off. During the same period the point of application was changed from the pump suction well to the flume between the coagulating and settling basins. Introducing the chemical at this point has not affected the settling of the floc. As a result of these measures, the fluoride concentration now varies only 0.2 ppm, from a low of 0.9 to a high of 1.1 ppm.

Another problem of feeding has been encountered. Two or three bags of silicofluoride in one shipment were very difficult to feed. The material, contrary to reports, had absorbed moisture. This condition was so pronounced that the feeding zone in the hopper was confined to a column approximately 2 in. in diameter and extending vertically throughout the full depth of the chemical. This situation required the attention of the operator every few minutes, although the hopper is equipped with an agitator. The condition was greatly improved by suspending an infrared lamp in the hopper to dry the chemical.

Another precaution was taken in connection with the fluoridation program. The local ice manufacturer was advised to pump out the core on each block of ice. This had not been done in a consistent manner prior to that time. As a means of impressing him with the need for taking this action, one of the cores was sampled and found to contain 8 ppm fluoride. The cracking of ice experienced at Charlotte has not occurred at Fort Mill.

As of October 1952, the company was paying $9.42 per hundredweight of sodium silicofluoride delivered. With a dosage of 1 ppm fluoride (approximately 13.74 lb of chemical per 1 mil gal of water treated), the chemical cost amounts to 1.29 cents per 1 mil gal, or approximately 8.5 cents per capita per year.

Need for Precautions

The responsibility involved in the proper application of a chemical classed as a poison cannot be overemphasized by the supervisor when cautioning the operators on proper handling and operation. Some water works, such as that at Fort Mill, have a constant raw-water flow into the plant, which greatly reduces the adjustments necessary for proper dosing.

There are certain elements in every machine which require particular attention for it to function as it should. These points should be carefully explained to and thoroughly understood by each operator. An occasional reminder, either written or oral, will keep the operator's attention focused on these points. As an illustration, it is worth mentioning an incident which occurred during the first month of operation of the fluoridation equipment at Fort Mill. The feed machine is of a type that will alarm on either under- or overdosing. In the filling operation, the beam is locked in a neutral posi-

tion. On one occasion after the hopper was filled, through some oversight on the operator's part only one lock was readjusted. This placed the machine in the position of "calling for feed" but being able to supply only part of this demand. The dosage is so low that even the small quantity fed was more than necessary. Actually the overdose amounted to only 0.6 ppm and was revealed by a test in 2 hours. Incidentally, 2,470 fluoride tests were made between May 16, 1951, and Mar. 1, 1952. Such tests, although time consuming, have not proved burdensome or caused neglect of other work.

A rule that requires the operator to stay at the plant at all times while it is in operation has been established. This is a good practice to follow in any plant.

To sum up, the operator should recognize his responsibility to the public, use the utmost care in dosing, understand the value of analyses, practice care in handling fluorides (dust masks and rubber gloves are standard equipment), be alert to improve the uniformity of feed, and take pride in having a part in furnishing an additional service to his customers.

Aberdeen, S.D.—*W. P. Wells*

A paper presented on Sept. 14, 1952, at the Minnesota Section Meeting, Minneapolis, Minn., by W. P. Wells, Supt., Filtration Plant, Aberdeen Water Dept., Aberdeen, S.D.

The Aberdeen, S.D., supply is obtained from the Elm River and its tributaries. Like many surface waters, it is low in natural fluoride content, the amount varying from zero to 0.3 ppm, with an average of 0.2 ppm. The Aberdeen installation consists of a softening plant with primary and secondary settling, carbonation, and filtration. The softening reactions are completed in the primary basin, where there is a slight loss in fluoride content, probably 0.05–0.10 ppm. It was deemed advisable to keep the fluoride feeder on the operating floor with all the other feeding equipment. The fluoride compound, sodium silicofluoride, is fed into the secondary mixing basin after the softening reactions have been completed and the excess lime removed by carbonation. Although it is believed that there is practically no loss of fluoride in this basin, arrangements are being made to feed directly into the clear well.

Sodium silicofluoride is obtained in 425-lb barrels as a dense white powder, containing approximately 60 per cent fluoride. The dry-feed machine has no dust control mechanism, but it has been found that, with ordinary care, little dust is raised. Each operator has been instructed in the precautions to be taken in handling the chemical and has been furnished with gauntlet type rubber gloves and an approved dust mask. The chemical is transferred from the barrel directly to the hopper. The dry feeder has operated in a very satisfactory manner. At first, however, considerable trouble was experienced in its operation, due mostly to unfamiliarity with the equipment. Also, the metal connection in the solution feed line corroded more rapidly than was expected. Hard-

rubber connections and rubber hose should be used with this solution.

Fluoride Determinations

Aberdeen maintains a 1.00-ppm fluoride residual in the finished water. Daily samples are obtained from town and from the filter plant. To faciliate fluoride determinations, a slide type color comparison unit was purchased. It was not possible to get good color matchings even with distilled water containing known fluoride concentrations. Three different alizarin indicator solutions were tried and a daylight lamp was used, but without success. The colors not only did not match, but showed uniformly lower readings in the 0.8–1.0-ppm range.

The method and solutions for fluoride determination developed by William L. Lamar (*1*) are now being used at Aberdeen. Good, sharp color matches are obtained with this procedure, using 50-ml Nessler tubes and a constant source of daylight illumination. Cleanliness is required of all equipment in running colorimetric determinations. This point cannot be stressed too much. Very sharp color differentiations can be obtained if the comparisons are made in a dark room, with the light source confined to the surface reflecting up through the tubes. As a slight increase, 0.05–0.1 ppm, in the overnight readings has been noted, all the samples and standards are permitted to stand overnight.

Costs

Sodium silicofluoride is purchased at a cost of $8.20 per hundredweight delivered. A typical dosage is 14.1 lb of chemical per 1 mil gal of water, at a cost of about $1.15. Distribution samples vary from 0.85 to 1.05 ppm fluoride, with the average residual near 1.00 ppm. It is planned to raise the fluoride concentration to the 1.2-ppm level, as authorized by the state health department. The cost of the fluoridation program is absorbed by the water department, an arrangement of which the author does not approve for at least two reasons: [1] fluoridation is not necessary to the production of a safe, palatable water, and the cost should rightfully be borne by the health department; and [2] publicity for the program can be better continued if a special levy is made every year.

It might be mentioned that the fluoridation program was in effect for two months before the public was informed. The announcement was delayed to eliminate unjust complaints. Since that time there has been no adverse criticism of the program.

Reference

1. Lamar, William L. Determination of Fluorides in Water. *Ind. Eng. Chem., Anal. Ed.*, **17**:148 (Mar. 1945).

Industrial Water Use

Task Group Report

A report of Task Group A4.D1—Industrial Water Use, presented on May 6, 1952, at the Annual Conference, Kansas City, Mo., by H. E. Hudson Jr. (Chairman), Head, Eng. Subdiv., State Water Survey, Urbana, Ill. Other members of the task group include C. H. Capen, R. W. Davenport, H. R. Hooper, H. L. McMullin, W. J. O'Connell, S. T. Powell, M. J. Sassani, R. G. Snider, and C. V. Youngquist.

TASK Group A4.D1 was originally set up to study the water requirements of specific industrial operations and to collect information from widely scattered industrial units in order to develop consumption requirements per unit of product. The committee has thus far limited itself to a review of work already in progress in this field.

Terminology

Some evidence of lack of uniform terminology in the field of industrial water use is apparent. To overcome inconsistencies, the task group has adopted two definitions which are recommended for use throughout the profession:

INDUSTRY, *noun:* a group of establishments producing a single product or closely related group of products. The term may also be used generically to take in all or several types of industries.

ESTABLISHMENT, *noun:* a single physical location where business, service, or industrial operations are performed.

Of the terms involved in studies of industrial water use, the most troublesome one to define is the word "consume" and its derivatives. Clearly, water is consumed when it is taken from a source and not returned to another source in liquid form. Consumption takes place either through evaporation of the water or through its dissipation in the product. Beyond that, at the present time, it would seem proper to define as consumptive those uses in which water is returned to the source in an impaired condition such that the source no longer meets the local requirements for water quality. This latter use of the term does not seem entirely necessary inasmuch as industries, under the prodding of conscience and of health agencies, are moving toward the elimination of serious water quality impairment through the adoption of improved processing techniques and waste water treatment. In time consumptive use resulting from quality impairment should become comparatively unimportant.

Magnitude of Industrial Use

The immense extent of water use by industry is not generally recognized. Wolman (*1*) estimates industrial requirements at 20–25 bil gal daily for 1950, when public water supply requirements were approximately 14 bil gal per day. Wolman's estimate must have excluded some condenser water needs, for Picton (*2*) and MacKichan (*3*) cite industrial requirements of the order of 80 bil gal daily, including steam power plant condenser water.

Picton (*2*) and MacKichan (*3*) agree on the distribution of water use in the United States in 1950 given in Table 1. The value given for industrial use apparently includes very large quantities for steam power plant condenser use. In Illinois, for example, this one use accounts for three-fourths of the industrial pumpage from separate sources. If it is assumed that half the national industrial use takes place in establishments other than steam-generating stations, industrial requirements are still approximately three times the amount distributed by public water supply systems. Use for irrigation is seven times that of the cities.

TABLE 1

Water Use in United States in 1950

Use	Daily Consumption *bil gal*
Municipal (public)	14
Industrial (private)	81
Rural (farmstead)	5
Irrigation	100

It seems probable that nearly half of the water pumped by public supply systems goes to industrial users.

Water works men thus find themselves among the minority in water use. This does not mean that public supply is of minor importance, for most water rights doctrines accord it priority over irrigation and industrial uses. The water works profession, however, is cast in the role of the tail that attempts to wag the dog, a situation which may require the development of some new techniques.

Other Studies

Early work on industrial water use was published by Jordan (*4*) in 1946 and a subsequent article by Powell and Bacon (*5*) appeared in 1950. Industrial water use may be subdivided into the following classes: cooling, processing, power generation, sanitary services, fire protection, and miscellaneous. Hauck has prepared a more detailed classification (*6*).

W. F. Guyton (*7*) has presented a classification, by industries, of use of ground water in twenty selected metropolitan areas. He lists the following industries: oil refining, paper manufacturing, metal working, chemical manufacturing, buildings, air conditioning, refrigerating, distilling, ice manufacturing, meat packing, brewing, railroad yards, gas and electricity, dairying, electrical-equipment manufacturing, aircraft assembling, resinous-products manufacturing, soap manufacturing, laundering, glass manufacturing, rope milling, shipyards, tobacco processing, and miscellaneous.

The report on domestic and industrial water supply and pollution by the Water Policy Panel of the Engineers Joint Council (*8*) constitutes an excellent review of industrial water use.

The National Association of Manufacturers, in cooperation with the Conservation Foundation, has made a study (*9*) of industrial water use from information supplied by 3,057 plants. The study classifies plants by the amount of water intake and the percentage of total intake which is reused. The study deals with a number of plants that have facilities for treating water, and gives details, such as the percentage of plants, by industry, whcih have facilities for treating water. Tables present data on types of treatment applied to water; the degree to which waste water is treated, by size of plant; and the percentage of plants which treat waste water before disposal. The methods used in the disposal of waste water are shown graphically and the plants are classified according to the amount of discharge. Final interpretation on water use per

unit of product is being completed. Some of the data were cited by Wolman (*1*). The Conservation Foundation is continuing this study through collaboration with the trade associations representing the major water-using industries.

MacKichan (*3*) summarizes some of the work that has been done by the U.S. Geological Survey at the request of the National Security Resources Board. The U.S. Geological Survey is continuing its work in this field in an effort to obtain more information on water requirements per unit of industrial product, and it is understood that this study will be completed and published within a year or two.

Simultaneously the U.S. Public Health Service has begun intensive work gathering data on waste disposal. Some of the results of its work are summarized in "Water Pollution in the United States" (*10*) This particular publication is very general, but the subsequent publications in this water pollution series deal in some detail with fifteen major drainage basins in the United States (*11*). Even these reports are merely summaries of the data collected on industrial waste disposal. They include tabulations of the various industrial establishments in each part of the basin, but they do not segregate the establishments on the basis of source of water supply. Many of them are undoubtedly using water from municipal systems, and their water use, therefore, is accounted for under the municipal pumpage.

Unsatisfied Needs

There is need for the development of conservation practices in water supply work for industry. Much of this need rises out of the lack of dissemination of information on projects already in progress. A useful service can be carried on by gathering together information on these practices, which involve measures such as: [1] substitution of waters of normally undesirable character for potable waters; [2] use of mechanical conservation equipment to dissipate heat energy to the atmosphere rather than to a water source; and [3] use of other alternative methods for water conservation, such as direct dissipation of heat to the atmosphere rather than through the medium of water, and multiple-use techniques.

Engineers in industry, in public water supply systems, and in appropriate governmental agencies should give thought to the possibility of initiation of new methods for water conservation—for example, combined ground and surface water systems. Under the economic stimuli that control present-day society, these developments would ordinarily take place in the areas where water requirements most nearly equal or exceed the available sources.

Industrial establishments generally look upon process water as one of the "taken-for-granted" utilities, which should be arranged simply so that it need not be given further thought. This thinking generally leads to oversupply and some waste of funds and water in the interest of concentrating attention on the product that is to be sold. Undoubtedly this attitude will change as pressure for water conservation increases through the approach of water use to the limit of the available resources, and through the growth of public opinion. Both are on the upgrade today.

The compilation of data on available water resources throughout the United States is a task that exceeds the capabilities of any committee organization. It is one that can be carried on only by full-time professional governmental

personnel. The task is being attacked by federal and state agencies, although it may be noted that local support for the necessary fact-finding program is generally feeble until actual shortages impend.

Cost of Industrial Water

Several members of the committee have worked on studies of industrial water costs, which are extremely variable, ranging from low figures in portions of the humid regions to very high values in the arid zones. The price which a given industry can pay for water appears to vary with the amount of water available and the geographic location of the particular establishment. Studies to determine the economics of industrial water supplies should be continued.

Quality Requirements

In certain industrial plants, as many as seven different qualities of water may be required, ranging from very high-grade distilled water to turbid, condenser cooling water. Water uses in industry may be classified under seven headings (*3*): cooling, solvent, catalyst, conveying medium, plant cleansing agent, production and distribution of heat and power, and worker use and lubricant.

Each of these seven uses may pose a different requirement for quality and temperature. Within a given classification, the requirement may vary from plant to plant—for example, cooling water in a plant distilling volatile organic solvents may have to be of lower temperature than that used for condenser cooling in a steam power generation plant. Certain chemical and biological processes require water at temperatures below 60°F, which cannot be attained under normal reuse techniques without the utilization of expensive energy and equipment for refrigeration. Such plants are therefore frequently located in places where quantities of ground water of suitable temperatures are available the year round. These institutions very commonly exploit ground waters for heat disposal throughout the year, although considerable conservation might be possible through substitution of variable surface waters at those times when the temperatures are sufficiently low.

Institutional Arrangements

Public water supply systems have access to the right of eminent domain to secure water wherever it can be found. This right is not generally available to industrial users, who must either locate themselves so that water may be secured through riparian rights or through ownership of land overlying the ground water resources. The industrial user, therefore, has much less flexibility in seeking water than does the public water supply specialist. For this reason, industrial users are sometimes limited to sources not well suited to their needs and which might better be used for other purposes. Frequently the laws do not make it convenient for industries to group together into water supply units. The provision in state and local statutes of methods whereby industrial requirements may better be met will therefore frequently serve to reduce the competition between public and industrial water supply.

Joint ventures of public and industrial supply might well be instituted. If mutually acceptable rate structures can be established, industry prefers to leave the securing of water to the public system.

Classification

None of the classifications of industrial water use in existing studies at-

tempts to show how the water source is used in industry. Sometimes the existing surveys break down industrial water into two classes—that which is used and that which is reused. None of these surveys is greatly concerned with place of disposal or possibility of transfer of the water, as from ground to surface sources or from surface waters into the atmosphere. Nor is it felt that water taken from underground sources and rejected to a river or the atmosphere should be grouped with river water returned unimpaired to the river. Thought should be given to the possible dislocations industry may cause in the hydrologic cycle.

Classifications generally reflect conflicting viewpoints. The water works industry is interested in supplying an adequate amount of water. From a water resources standpoint, the important consideration is the relationship of industrial demands to existing and potential water sources. The industrial user is interested in an adequate water supply for his manufacturing needs. Public health has interests that may conflict with these other viewpoints; health specialists may be concerned with the dependability and effectiveness of waste water treatment.

A classification of industrial uses prepared to recognize these viewpoints and to arrive at an outline of information necessary to permit any interest to evaluate water use in terms of its own problems is given in an appendix to this report (page 294).

Summary

Industrial use of water has outstripped public water supply in magnitude. Although this country is far from the national saturation point in use of water resources, industrial requirements are competing vigorously with public systems in some areas. This trend toward increasing industrial use must be watched by the one group that has a good technologic background, a sincere interest, and a top-priority stake in water resources—the professional water works men.

Future Committee Work

The following avenues of work are open to this task group:

1. To keep track of and coordinate studies of other national groups and agencies in the field of industrial water requirements. The gathering of water resources and detailed water use data is a task that is beyond the resources of the committee. About all the task group can do is summarize work in progress in these fields. Two of the national groups that are gathering water resource and detailed water use data are now represented on this task group—the Conservation Foundation and the U.S. Geological Survey. A representative of the U.S. Public Health Service should be added to the task group membership. These agency representatives might well undertake to keep this task group advised of accomplishments in their agency's programs.
2. To embark on a program of gathering data on costs of privately developed industrial water supply systems. A program of systematic inquiry will be necessary. Possibly committees in the various sections could conduct this program for the task group.
3. To gather information on methods of organizing to enable industries to secure water to meet their needs.
4. To gather information on conservation practices in industrial water use that reduce demands on potable water resources.

These are tasks that can best be carried out through federal and state water

resources agencies. As there is no national organization encompassing all such agencies, these information-gathering jobs may have to be undertaken by the task group in the form of questionnaires to the agencies. Uniform coverage will not result, but the harvest of ideas may still be rewarding.

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3. MacKichan, Kenneth. Estimated Use of Water in the United States. *U.S. Geological Survey Circ.*, No. 115 (May 1951).
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5. Powell, S. T., & Bacon, H. E. Magnitude of Industrial Demand for Process Water. *Jour. AWWA*, **42**: 777 (Aug. 1950).
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7. Guyton, W. F. Industrial Use of Ground Water. Paper presented at the 35th annual meeting of the Technical Assn. of the Pulp & Paper Industry, New York (Feb. 1952).
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9. Water in Industry. National Assn. of Manufacturers, New York (Dec. 1950).
10. Water Pollution in the United States. *Water Pollution Series*, No. 1. U.S. Public Health Service (1951).
11. Missouri River Drainage Basin—Summary Report on Water Pollution. *Water Pollution Series*, No. 3. U.S. Public Health Service (1951).

APPENDIX

Outline of Facts Necessary for Classifying Water Use in an Industrial Establishment

A. Industrial Category (check one)

- Aircraft assembling ....
- Brewing ....
- Buildings, air conditioning ....
- Chemical manufacturing ....
- Dairying ....
- Distilling ....
- Electrical-equipment manufacturing ....
- Food processing ....
- Gas and electricity ....
- Glass manufacturing ....
- Ice manufacturing and cold storage ....
- Laundering ....
- Meat packing ....
- Metal working ....
- Oil refining ....
- Paper manufacturing ....
- Railroad yards ....
- Resinous-products manufacturing ....

A. (*contd.*)

- Rope milling ....
- Rubber manufacturing ....
- Shipyards ....
- Soap manufacturing ....
- Tobacco processing ....
- Other ....

B. Water Supply Agency (check one)

1. Municipal system ....
2. Industrial development ....

C. Intake of Water

1. Ground water
   a. Wells or springs ....gpd
   b. Other source ....gpd

2. Surface water
   a. Lake, river, channel, or ditch ....gpd
   b. Other source ....gpd

D. Source

1. Potential capacity ....gpd
2. Installed capacity ....gpd

E. Disposal of Water

1. Returned to
   a. Source from which taken ....gpd
   b. Places other than source ....gpd

2. Place of Disposal
   a. Ground water ....gpd
   b. Surface
      (1) Lake, river, channel, or ditch ....gpd
      (2) Sewer ....gpd
      (3) Pond or lagoon ....gpd

E.2. (*contd.*)

   c. Discharged with product ....gpd
   d. Evaporated ....gpd

F. Water Use—Rate of Circulation

1. Conveying medium ....gpd
2. Diversion (such as dewatering a mine) ....gpd
3. Cleansing agent ....gpd
4. Cooling ....gpd
5. Lubricant ....gpd
6. Catalyst ....gpd
7. Conversion and distribution of energy ....gpd

NOTE: Flow figures in gallons per day should represent yearly average use rather than installed capacity. If possible, secure data on seasonal variations. If reuse is practiced, show rate of flow for each use category.

G. Net Changes in Quality

Type of Use	Net Change					
	Dissolved Materials *ppm*	Temperature—°F	Suspended Materials *ppm*	BOD *ppm*	Toxic Materials *ppm*	Color *ppm*
1. Conveying medium						
2. Diversion (such as dewatering a mine)						
3. Cleansing agent						
4. Cooling						
5. Lubricant						
6. Catalyst						
7. Conversion and distribution of energy						

Report of the Committee on Water Works Administration

For the Year Ending December 31, 1952

A report of the activities of the Committee on Water Works Administration for the year ending Dec. 31, 1952, submitted to the AWWA Board of Directors on Jan. 19, 1953, by Wendell R. LaDue, Chairman.

As outlined on pages 182–84 of the 1952 AWWA *Directory,* the present organization of the Coordinating Committee on Water Works Administration provides for nineteen subcommittees grouped in four classifications. The general committee consists of the chairman, the general chairmen of the four groups, and the chairmen of the various active subcommittees. Other members of the various subcommittees are not members of the Committee on Water Works Administration. Committee work has been widened by the creation of "task groups," subordinate to standing committees. The chairman of a task group is not a member of the Committee on Water Works Administration, but, in general, works within the province of the division under which the task group functions. The present committee personnel are:

W. R. LaDue, *Chairman*

F. C. Amsbary	M. P. Hatcher
L. E. Ayres	A. P. Kuranz
J. J. Barr	D. L. Maffitt
M. B. Cunningham	C. E. Moore
R. J. Faust	L. A. Smith
E. L. Filby	A. A. Ulrich
L. S. Finch	W. V. Weir

H. E. Jordan, *ex officio*

Committee activities and personnel were given considerable study, resulting in the following changes, additions, and reallocations.

Coordinating Committee Personnel Changes

1. W. V. Weir: to general chairman of Committee A3—Financing; from general chairman of Committee A1—Organization and Administrative Policy.

2. M. P. Hatcher: to general chairman of Committee A1—Organization and Administrative Policy; from general chairman of Committee A3—Financing.

3. A. A. Ulrich: replaced C. J. Alfke as chairman of Committee A1.D—Water Use in Fire Prevention and Protection. Chairman Ulrich, therefore, becomes a member of the Committee on Water Works Administration.

4. J. J. Barr: appointed chairman of Committee A4.E—Committee to Cooperate With National Association of Railroad and Utilities Commissioners (NARUC) Committee on Revision of System of Accounts for Water Utilities. Chairman Barr, therefore, be-

comes a member of the Committee on Water Works Administration.

5. The practice of including the secretaries of the Water Purification, Water Resources, Transmission and Distribution, and Water Works Management Divisions as members (ex officio) of the Committees on Water Works Administration and Water Works Practice was discontinued with the concurrence of W. R. LaDue, L. R. Howson, and H. E. Jordan, and with Board approval.

Changes in Subcommittee Organization

1. Committee A1.B—Radio and Mobile Communication Facilities for Water Works. Adolph Damiano requested relief from duty.

2. Committee A1.D—Water Use in Fire Prevention and Protection was organized under the chairmanship of A. A. Ulrich.

3. Committee A2.E—Safety Practices, R. J. Faust, Chairman, was expanded as follows:

Task Group A2.E1—Supply, Jerome Powers, Chairman

Task Group A2.E2—Treatment and Pumping, Oscar Gullans, Chairman

Task Group A2.E3—Distribution, K. A. Day, Chairman

Task Group A2.E4—Administration, R. A. Edwards, Chairman.

4. The Committee on Construction, Equipment, and Material Contracts was changed from A1.E to A3.A.

5. The Committee on Taxation and Fund Diversion was changed from A3.A to A1.E, and its title was changed to Taxation and Revenue Allocation.

6. Committee A4.A—Water Department Reports completed its assignment and was discharged with thanks. M. P. Hatcher was retained as adviser.

7. For Committee A4.C—Joint Administration of Water and Sewer Facilities, L. N. Thompson was appointed as adviser.

8. In Task Group A4.D1—Industrial Water Use, R. G. Snider resigned and Stephen Bergen, L. L. Hedgepeth, and L. F. Warrick were added.

9. Committee A4.E was organized to cooperate with the NARUC committee engaged in the revision of the system of water utilities accounts.

Inactive Subcommittees

The following subcommittees are now inactive or have not been activated:

A1.E—Taxation and Revenue Allocation

A2.B—Management Relations

A3.A—Construction, Equipment, and Material Contracts

A3.B—Valuation and Depreciation

A3.C—Cost Trends

A4.A—Water Department Reports (adviser retained)

A4.C—Joint Administration of Water and Sewer Facilities (adviser retained)

A4.D2—Domestic Water Use (functioning as a comparatively inactive task group).

1952 Conference

At the 1952 Conference, eight principal items stemming from the committee's activities, either directly or indirectly, were presented:

Committee	Work	In Journal
WWA	Open meeting: A general discussion of the activities of the various subcommittees	——
WWA	Paper: The Place of the Manufacturer in the Water Works Industry	Sept. 1952, p. 829
A1.E	Panel: Relocation of Water Works Facilities in Highway Construction	Sept. 1952, p. 835
A2.A	Panel: Meeting Flood Problems	Sept. 1952, p. 811
A2.A	Panel: Getting Along With: Mayors and Councils; Employees and Customers; a Boom Municipality	Oct. 1952 *
A2.E	Paper: The Water Works Industry Needs a Safety Program	Feb. 1953 *
A4.B	Panel: Selling Rate Adjustments to Citizens	Dec. 1952, p. 1151
A4.D1	Report: Industrial Water Use	Mar. 1953, p. 289

* In *Willing Water*.

Subcommittee Activities

The continuing growth of interest in the various phases of water works management is indicated by the numerous inquiries and increased attention to the progress of the various subcommittees and the continuing and often almost impatient demand for the expansion of the committee's program into other phases of water works administration.

The following is a brief resume of the activities of the various subcommittees during the year 1952.

A1.A—Constitutional and Statutory Aspects of Municipal Water Works Organization. Following evidence of need for basic information, it is planned to conduct an AWWA staff survey to ascertain what powers the various states have conferred upon unincorporated population groups to organize and incur indebtedness to build public water works systems. It is recognized that all water works operations rely upon enabling state legislation for the legality of their functions. The multiplicity of state and province laws presents no end of interesting and sometimes puzzling situations.

A1.B—Radio and Mobile Communication Facilities for Water Works. A survey on radio use by water departments was completed and reported at the 1952 Conference. Activities were continued anticipating more publicity by manufacturers in advocating use of radio by water departments. Contact was maintained with the National Committee on Utilities Radio. It is proposed to have a water department representative at all regional and national meetings of this committee. It is observed that water departments in general are exhibiting increased interest in the possibilities of the use of radio in their normal operations.

A1.C—Water Use in Air Conditioning and Other Refrigeration. Little fundamental change has occurred since the publication of the report of this committee in the December 1950 issue of the Journal. It is considered desirable that the subject be revised by a paper at the 1953 Convention, with particular reference to the legality of restrictive rules and regulations.

A1.D—Water Use in Fire Prevention and Protection. This committee was reorganized Nov. 18, 1952. Obviously, little has been accomplished to

date except to outline the initial problem. Currently the committee expects to devote its activities to the following projects: [1] a review of present rate classification[9] schedules developed by the National Board of Fire Underwriters; and [2] a study of insurance evaluation and problems of proper amounts of insurance on water works properties.

A2.A—Public Relations. Routine assistance to the AWWA staff in preparing *Willing Water* has continued. As the Board is to give consideration to requesting the U.S. Post Office Dept. to issue a stamp for the seventy-fifth anniversary of the Association, this committee's personnel have offered their service to the project.

A2.C—Compensation of Water Works Personnel. Following the report at the 1951 Conference, it was felt that the results of the work of the committee did not justify the creation of a national formula, because local conditions greatly affect the problem. With this in mind, the work of the committee is subject to self-review in the hope that more realistic objectives may be set.

A2.D—Pension and Retirement Plans. No active program was in force during 1952. This subject is in a state of flux owing to national attitudes toward pensions and to more recent acts of state legislation. Pressures are continuing to place state pension systems under the Federal Social Security Act. It is believed that the question should be reexamined and reevaluated in line with these changes. The committee should report its findings to the Association at an early date.

A2.E—Safety Practices. Work in this vital field has been carried on actively by the committee. In January 1952 the Board of Directors, at the request of Chairman LaDue, authorized the formation of four task groups to study and report on safety practices as they relate to supply (A2.E1), treatment and pumping (A2.E2), distribution (A2.E3), and administration (A2.E4). These groups are prepared to report their findings at the 1953 Conference. Two of these task groups prepared and sent out questionnaires to obtain information for their reports. Progress is being made in other directions. For example, all sections have been requested to form a committee on safety practices and, if possible, to schedule papers or panel discussions on this subject at section meetings. It has also been suggested that the curriculum for short courses include safety practice materials as an item of study. The committee proposes the following multiple-point program of Association activity in the field of safety: [1] prepare and publish a safety practice manual for water works utilities; [2] prepare a simple report form for recording accidents; [3] join the National Safety Council; [4] publish objective papers in the JOURNAL on safety practices and the results obtained (several have already appeared); and [5] use *Willing Water,* at intervals or regularly, to disseminate methods of safety practices as used and developed in the industry. On Dec. 16, 1952, by request of Chairman LaDue, the Executive Committee of the Public Utilities Section of the National Safety Council adopted a resolution accepting the water utilities as an official component. No recent activity in the administrative field has created more member interest and active participation than safety.

A3.D—Water Main Extension Policy. This committee has been con-

tinuously active. A report is in preparation for the 1953 Conference with special consideration of suburban main extensions. With the trend toward suburban development, this report will be particularly timely.

A4.B—Water Rates. The committee continued to study this subject, but there has been no satisfactory reconciliation of differences in viewpoint to permit a report. If the budget will permit, a special meeting of the committee has been proposed at some time prior to the 1953 Conference.

A4.D1—Industrial Water Use. This task group submitted a comprehensive report at the 1952 Conference. The September 1952 issue of *Power* used this report as a basis for a review of material concerning water in industry. It is believed that the objectives of the task group should be reviewed and consideration given to its future development. This subject is of growing importance and, it is believed, commands a higher rating in the Association's activities than is indicated by the task group classification. Two courses are open: either to continue it as a function of the Water Resources Division or to give it committee status as the Committee on Water Use, including both industrial and domestic. Developments prior to the 1953 Conference will help decide this issue.

A4.E—AWWA Committee to Cooperate With NARUC Committee on Revision of System of Accounts for Water Utilities. This committee was recently organized to cooperate with a committee of NARUC in developing a uniform system of accounts for water works utilities. A tentative draft of the new system has been prepared for discussion by the NARUC committee in January 1953. The committee has examined the system, but it is believed that no formal action will be taken by NARUC before the fall of 1953, as the draft has not been cleared for distribution to the utilities in general.

The attention of the Board is directed to the need of enlarging the activities of the Committee on Water Works Administration along several lines. With this in view, it is recommended that the following subcommittees be activated:

A1.E—Taxation and Revenue Allocation. This has always been a vital subject to water works management. It has become more so in recent years with large highway construction requiring large allocations of water works revenue to highways without the usual increase in capital value. Likewise the growing tendency toward indirect taxation of water works funds for general city expenses affords much food for discussion. The effect upon water rates of such procedures is by no means incidental. This committee, with Committees A3.D and A4.B, covers a live and moving field in water works management.

A4.D—Water Use. The continuing problem of water use and allocation is a vital subject. For several years this work has been handled by task groups. It is believed that the time has arrived for careful consideration and fixing of the scope of this work, which will result in committee status.

Report of the Committee on Water Works Practice

For the Year Ending December 31, 1952

A report of the activities of the Committee on Water Works Practice for the year ending Dec. 31, 1952, submitted to the AWWA Board of Directors on Jan. 19, 1953, by Louis R. Howson, Chairman.

FOLLOWING is a report of the technical committee activities of the Association conducted under the guidance of the Committee on Water Works Practice during the calendar year 1952:

E7.A—Steel Pipe. The committee is continuing its investigations into the use of Fiberglas as a reinforcement for coal-tar enamel. Adverse comments concerning the reduction in weight requirements of the asbestos wrapping material have been filed by President Capen. The committee has reported no progress in its development of specifications for cement-mortar lining. Section 7-4—Field Application of Cement-Mortar Lining was officially withdrawn by the Board, Jan. 1, 1951.

Cast-Iron Pipe. A major portion of AWWA activities in the field of cast-iron pipe standardization is carried on under the jurisdiction of ASA by Committee A21. A separate report of the progress made by that committee appears as Appendix A to this report. As of the end of December 1952, all of the pending documents in the field of cast-iron water pipe had been approved by the ASA Board of Review and awaited the formal notice of this approval from the Technical Secretary of ASA. A discussion of the significance of these standards is scheduled for the 1953 Conference.

Variations in the dimensions of the various types of pipe, of the same nominal diameter, have been noted by several engineers. It appears desirable to develop a memorandum of information for purchasers of cast-iron pipe which will make these differences in bell and spigot dimensions clearly understandable so that they may be protected in future orders of this material.

In accordance with the directive of the Board at its annual meeting in January 1950, the sections of the 1908 Specifications for Cast-Iron Special Castings have been redeveloped in a new document, Specifications for Cast-Iron Pressure Fittings—AWWA C100–52T. This document has been approved by the Board by letter ballot and will be published in the March 1953 issue of the JOURNAL (*this issue,* page 321). Exception has been taken to the paragraph "Quality of Iron" in the document by a member of the Committee on Water Works Practice, who recommends that the iron be required to meet the physical requirements of ASTM A48. This suggestion will be carefully reviewed before the document is recommended for advancement to standard status.

E7.D—Laying Cast-Iron Pipe. A special assignment has been given to H. E. Lordley to develop a section on the procedure for installation of cast-iron water mains to cover the installation of mechanical-joint pipe. This work is in progress and will be sub-

mitted to the Water Works Practice Committee and the Board of Directors for approval for publication during 1953.

E7.D1A—Investigation of Sulfur Jointing Compounds. Chairman Weir of the special task group charged with this investigation continues his studies but is not yet prepared to file a report.

E7.D2—Disinfection Procedure. A revision of the current Procedure for Disinfecting Water Mains (C600–48) was prepared by the committee and submitted to the Water Works Practice Committee for consideration. [Following approval by that committee, the document has been submitted to the Board for final approval and authority to publish as an official AWWA document.]

E7.E—Asbestos-Cement Pipe. As of Oct. 12, 1951, the revised text of the Specifications for Asbestos-Cement Pipe was transmitted by Chairman Clark to the Committee on Water Works Practice. Following this submission, reference was made to the status of the document on page 256 of the March 1952 issue of the JOURNAL. The document was discussed during the 1952 Conference, and the differences of opinion then expressed by certain members of the Committee on Water Works Practice have not been resolved. A consensus has not been developed, and the specifications cannot yet be submitted to the Board of Directors for approval and publication.

E7.F1—Water Works Distribution Gate Valves. This document, which has been under consideration for an extended period, was finally brought to the point of agreement and published in the September 1952 issue of the JOURNAL. Reference has been made to the problem of attack of high zinc bearing components by lime-softened waters, and consideration is being given to the addition to the document of certain types of bronze which are resistant to this type of corrosion.

E7.F3—Fire Hydrants. The special task group (set up to resolve the differences of opinion concerning the Specifications for Fire Hydrants which were apparent at the time of the 1952 Conference) has had several meetings and has carried on extensive correspondence. The differences of opinion are now resolved, and there is attached to this report, as Appendix B, an outline of the understandings reached. [The final text has been submitted to the AWWA Board of Directors for approval.]

E7.M—Meters. It has been decided to reactivate the Committee on Meters. Two subjects await the consideration of this committee. One is the propriety of use of plastic impregnation to correct defective conditions in castings. The second is to reevaluate the modifications in meter components recommended by the National Production Authority and accepted by the AWWA Board at its meeting in January 1952. Although the restrictions upon the use of materials have been lightened and the meter manufacturers have, to a substantial degree, resumed the production of standard units in accordance with the specifications, no official withdrawal of the amended specification has been submitted, as the NPA officials were apprehensive that the availability of materials would not continue for any length of time. The reconstituted Meter Committee should be charged with the task of appraising the acceptability in service of the modified type of meter and, if its judgment so indicates, should suggest that certain current modifications not be continued and others acceptable to the consumers be instituted.

Steel Pipe Flanges. During 1952 the work of the Joint AWWA-ASME Committee on Standard Specifications for Steel Pipe Flanges was completed. The document (C207-52) was published in the October 1952 issue of the JOURNAL. The committee now has in development dimensions for flanges for pipe larger in diameter than that covered by the 1952 document.

Steel Water Tanks. Extensive revision of the specifications for steel water tanks and their inspection, repair, and painting (D100-D102), were developed during the year and published in the August 1952 JOURNAL. Since the publication of these documents, objection has been raised to certain characteristics of paint corresponding to the U.S. Bureau of Reclamation Specifications CA-50, because of its taste-producing characteristics. A committee at the present time is reviewing the situation. [Deletion of CA-50 paint from the AWWA tank painting specifications, D102, was approved by the Board. See February 1953 JOURNAL, page 169.]

The Association has had made available to it during the year several documents on steel protection developed by the Steel Structures Painting Council. These documents are on "Surface Preparation," "Paint Formulation," "Paint Application," and "Paint Systems." Copies have been filed with the chairman of the AWWA Committee on Steel Pipe. H. O. Hill, chairman of the steel tank committee, has informally represented AWWA in the deliberations of the council. Request has been made that AWWA formally affiliate itself with the Steel Structures Painting Council and contribute to the expense of operation. No decision has been reached.

E6.A—Water Hammer. A committee to develop further information upon this subject has been formally appointed to operate under the chairmanship of S. Logan Kerr. A record of a discussion of the subject as presented at the 1952 Conference was published in the October 1952 issue of the JOURNAL.

E7.1—Breaks in Water Distribution Systems. A special task group has been set up for this study with Secretary Jordan as coordinator. Owing to the press of other matters, the study has not been properly put under way. It is expected that other staff activities will be reduced sufficiently to permit the work to begin shortly.

ASA A13—Scheme for the Identification of Piping Systems. Committee opinion leans heavily toward identification of pipe content by marking with a suitable legend giving the name in full or abbreviated form. The present standard color code (ASA A13-1928) of identification is considered to be of secondary importance. This program should lessen the chances of error and confusion, especially in times of emergency. The committee is nearing final approval of the revised document.

ASA B26—Fire-Hose Coupling Screw Thread. During 1952 the 1925 Standard for Fire-Hose Coupling Screw Threads (ASA B26) was reexamined by the sponsors and reapproved without change. This is colloquially called the "National 7½ Thread per Inch Standard." The past year brought to a focus a substantial difference of opinion among persons concerned with standardization in the Dominion of Canada. The Canadian Standards Assn. promulgated a standard for 2½-in hose couplings requiring five threads per inch. Attention of the Canadian authorities was called to the fact that the 7½-thread and the five-thread requirements for 2½-in. hose couplings made it impossible for inter-

national cooperation in times of great emergency. A special committee of the Canadian Section, under the chairmanship of W. E. MacDonald of Ottawa, reported strongly against the Canadian standard for fire threads and recommended that an alternate specification, comparable with the ASA B26 standard, be accepted by the Canadian Standards Assn. There is no present evidence that this recommendation will be accepted.

ASA B58—Deep Well Turbine Pumps. This committee was authorized by ASA in June 1949 and operates under the sponsorship of AWWA, with representatives of eight other organizations participating in the project. A complete draft of the text of the standard was sent to all committee members on Oct. 7, 1952. A review of all comments received was made on Oct. 31, 1952. Certain final adjustments of the text are in process. It is anticipated that the document will be ready for final approval by the committee members during 1953.

ASA K61—Storage and Handling of Anhydrous Ammonia and Ammonia Solutions. The increasing use of liquid ammonia for fertilizing the soil has accelerated the need for standardization of equipment for handling and storing this material. AWWA interest relates to aboveground storage and the establishment of a minimum permissible distance between ammonia storage tanks and water wells or surface streams.

ASA Y1—Standardization of Abbreviations. Following its organization meeting in October 1951, the work of Committee Y1 has been carried on by three subcommittees assigned the task of reviewing present standards for abbreviations and the need for new ones. To date no action by the sectional committee has been required, but preliminary drafts of a new standard for abbreviations to be used in text has been circulated by the subcommittee responsible.

ASA Technical Committee Z48.2—Method of Marking Portable Compressed Gas Cylinders to Identify the Material Contained. The technical committee in December 1952 voted on a revised marking code for cylinders. It dealt with quality, size, and location of cylinder marking.

Committees Under the Jurisdiction of the Water Purification Division

E5.B—Manual of Water Quality and Treatment. Three special task groups have been set up to revise chapters in the *Manual of Water Quality and Treatment.* The chapter on aeration is being revised by Chairman G. R. Scott with a special task group; the chapter on mixing, flocculation, and settling, by a special task group under H. E. Lordley's chairmanship; and the chapter on filtration, by a task group operating under the chairmanship of R. L. McNamee. Each committee proposes to present a progress report at the 1953 Conference.

E5.1—Specifications and Tests for Water Purification Chemicals. This project continues to progress under the direction of J. E. Kerslake. Six documents were published in 1950: ammonium sulfate, bauxite, ferrous sulfate, sodium chloride, sodium fluoride, and trisodium phosphate. In 1951 three documents were published: caustic soda, activated carbon, and soda ash. In 1952 Specifications for Aluminum Sulfate—B403-52T were published. Specifications for Quicklime and Hydrated Lime—B202-52T were published in the January 1953 issue of the JOURNAL. The following documents are still in preparation: copper sulfate, ferric sulfate, hypochlorites, so-

dium silicofluoride, hydrofluosilicic acid, and sodium bisulfite.

E5.6—Specifications for Filtering Materials. Minor amendments to this document are in progress, under the direction of Chairman Hazen. No report upon the matter has yet been rendered.

E5.7—Open Air Reservoirs. Norman J. Howard, who has been chairman of this committee for several years, resigned because of the press of other duties and E. L. Bean has been appointed to succeed him. A final report of this committee is scheduled for discussion in the business session of the Water Purification Division during the 1953 Conference.

E5.8—Disposal of Wastes From Water Purification and Softening Plants. The report of this committee is nearing completion, and it is expected that a report on the last phase of the committee's investigations will be ready for presentation at the 1953 Conference.

E5.10—Committee on Fluoridation Materials and Methods. This committee continues to be highly active, as the accumulation of new information upon the subject is of considerable magnitude. A report of this committee is expected at the 1953 Conference.

E5.12—Instrumentation and Methods of Testing Radioactive Contamination in Water. This committee presented a report at the 1952 Conference, which was published in the July 1952 issue of the JOURNAL. The committee continues its activities, with a report scheduled for presentation at the 1953 Conference.

E5.9—Standard Methods. The preparation of the text of the tenth edition of this important volume is approaching completion. This project, which is a joint enterprise of AWWA, APHA, and FSIWA, is being developed under the general chairmanship of Harry A. Faber, with AWWA's portion of the text in the hands of fourteen subcommittees organized and directed by Ray L. Derby.

Cross-Connection Control. During 1952 a Joint Committee on Cross-Connection Control was authorized, in which AWWA will cooperate with the Conference of State Sanitary Engrs. AWWA representatives—Richard Ellis, Ray Derby, and Andrew Dempster (chairman of the joint committee)—have been appointed. The representatives of the Conference of State Sanitary Engrs. have not been appointed at the date of this report, but it is anticipated that the committee will be organized and ready to work actively during 1953. AWWA issued reports on cross-connection control in 1931, 1932, 1934, 1940. A formal final report of the committee was published in the January 1942 JOURNAL. This report represents the current standard policy of AWWA on the matter of cross-connection control. It will be reviewed by the new joint committee in the light of mechanical and technical developments which have occurred during the intervening decade.

Joint Committee on Chlorine Supplies. This committee's function is to receive, analyze, and make suggestions for the alleviation of problems of distribution, transportation, storage, and use of chlorine for sanitation (water and sewage treatment) between manufacturer and user. One of the chief concerns of the committee relates to the question of when and where ton containers are justified. Other questions relate to the maximum number of chlorine cylinders to be used (connected) at one time; policy on return of containers and cylinders, with special emphasis on seasonal use of cylinders; routine to be followed in secur-

ing chlorine in an emergency; chlorine inventory at users' plants; recommendations concerning static chlorine storage at users' plants; transportation of chlorine, with special emphasis on trucking; standby chlorinating equipment; and safety in the use and handling of chlorine. The committee at present is trying to answer these questions in a code of reasonable practice.

The rescinding of NPA Order M-31 on Nov. 18, 1952, evoked an inquiry by the committee (Nov. 25, 1952) to NPA asking what help might be expected from that organization to secure public health chlorine in the event of an emergency. G. J. Bruyn, Chief, Alkalies Section, Chemical Div., NPA, replied on Dec. 3, 1952, that NPA will still be available for assistance in securing chlorine and that, in a national emergency, Order M-31 could be reinstated in two weeks' time.

It will be recalled that, in May 1952, the Board approved AWWA representation on the Public Health Advisory Committee of the Chlorine Institute. Other members represent the APHA, the Conference of Munic. Public Health Engrs., the Conference of State Sanitary Engrs., the FSIWA, and the U.S. Public Health Service. Two meetings were held with the Public Health Committee of the Chlorine Institute. As the membership of the joint committee and the advisory committee vary only slightly, an opportunity is provided to discuss all problems relating to chlorine with the manufacturers. Two meetings were held in 1952, and a third in late January 1953.

Committees Concerned With Water Resources Problems

E2.A—Task Group on Weather Control. This task group continues, with Robert A. Duff of Medford, Ore., succeeding E. H. Guyer as chairman. At the present time there are three organizations commercially active in so-called "rainmaking" operations. The U.S. Weather Bureau plans a study of natural and controlled rainfall in the Pacific Northwest area during the coming year. AWWA task group activities are minor at present.

E2.B—Production of Usable Water From Salt Water. This task group is under the chairmanship of W. F. Langelier. Studies with permeable membranes, which the chairman is carrying on, indicate the possibility that this method of desalting may operate competitively with vapor compression distillation. In his judgment, however, neither method is presently suitable or economically feasible for municipal water production. The U.S. Dept. of the Interior has appointed an advisory committee to guide it in its planned research program in the field of desalting sea water. The probabilities are that more substantial appropriations will be requested by the department for future activities. The task group believes that it should continue its activities for another two or three years, or until such time as the results of the researches now getting under way are made known.

E3.A—Watershed Protection and Erosion Control. The chairman of the Committee on Erosion Control plans a report for his committee at the 1953 Conference.

E3.B—Public Use of Watershed Areas. The chairman of this committee, L. S. Finch, is also the chairman of the Association's Committee on Water Main Extensions and has given his time to the latter subject during the past year. It is planned to develop an open discussion of the viewpoints relating to the public use of watershed areas during the 1953 Conference and to reorganize the committee upon the

basis of the information developed at that time.

E4.A—Deep Wells. This committee, under the chairmanship of James C. Harding, has completed its recommended procedure for sealing abandoned wells. The document was accepted by the Board of Directors and published in the October 1952 JOURNAL. The committee has no other work currently in progress.

E4.B—Artificial Ground Water Recharge. A report of this task group was published in the August 1952 JOURNAL, along with a discussion of the subject by Finley B. Laverty of the Los Angeles County Flood Control Dist. A paper upon the same subject, presented at the California Section Meeting by A M Rawn, is scheduled for publication in a future issue of the JOURNAL. A report upon the subject of ground water recharge presented at the Paris meeting of the International Water Supply Assn. has been made available to the chairman of the task group for his use in planning future activities.

E4.C—Underground Waste Disposal and Control. Chairman Norman F. Billings is compiling data on a national basis concerning the nature and severity of ground water pollution by waste disposal. A report is scheduled for presentation during the 1953 Conference.

APPENDIX A—ASA A21 Specifications

Significant progress toward ASA approval may be reported for all A21 specifications since May 1952, when the last report was made to the Board. Short-Body Cast Iron Fittings, 3 Inch to 12 Inch, for 250-psi Water Pressure Plus Water Hammer—A21.10–1952 (AWWA C110–52) was made an American Standard on Sept. 30, 1952. It was printed in the November 1952 JOURNAL. On Jan. 13, 1953, five additional specifications were approved: A21.2, A21.4, A21.6, A21.8, and A21.11.

The three specifications relating to the gas industry—A21.3, A21.7, and A21.9—have sponsor approval from ASTM, AWWA and NEWWA. Sponsor approval by AGA is expected momentarily [received Jan. 19, 1953].

Table 1 shows the status of each of the specifications.

TABLE 1—*Status of ASA Cast-Iron Pipe Specifications*

Specification	Approved by:						In JOURNAL
	A21 Com.	AGA	ASTM	AWWA	NEWWA	ASA	
A21.1—Cast Iron Pipe Manual	held						
A21.2—Pit Cast Pipe	6/25/52	10/17/52	9/17/52	9/15/52	9/26/52	1/13/53	*
A21.3—Pit Cast Pipe (Gas)	6/13/52	1/19/53	12/2/52	11/19/52	11/20/52		†
A21.4—Cement Mortar Lining	4/21/52	6/13/52	9/17/52	7/24/52	9/26/52	1/13/53	*
A21.6—Centrifugally Cast Pipe (Metal Molds)	4/21/52	10/17/52	9/17/52	9/15/52	9/26/52	1/13/53	2/53
A21.7—Centrifugally Cast Pipe (Metal Molds) (Gas)	6/13/52	1/19/53	12/2/52	11/19/52	11/20/52		†
A21.8—Centrifugally Cast Pipe (Sand-lined Molds)	4/21/52	10/17/52	9/17/52	9/15/52	9/26/52	1/13/53	2/53
A21.9—Centrifugally Cast Pipe (Sand-lined Molds) (Gas)	6/13/52	1/19/53	12/2/52	11/19/52	11/20/52		†
A21.10—Short-Body Fittings	1/12/49	1/18/52	2/28/52	5/4/51	1/17/52	9/30/52	11/52
A21.11—Mechanical Joint	6/30/52	10/17/52	9/17/52	6/30/52	9/26/52	1/13/53	

* Revised text; will be available as reprint but not published in JOURNAL.
† To be published by Am. Gas Assn., 420 Lexington Ave., New York 17, N.Y.

APPENDIX B

Revision of Hydrant Specifications

The Board of Directors, at its meeting in Kansas City, Mo., on May 9, 1952, following the presentation of the report of the Committee on Water Works Practice, authorized the appointment of a special task group to bring to a conclusion the discussions concerning the revision of the Standard Specifications for Fire Hydrants for Ordinary Water Works Service—C502-40 (formerly 7F.3-1940), which have been going on since the working committee made its report in December 1948. The group appointed consisted of C. H. Capen, R. H. Ellis, and H. E. Jordan, representing the consumer field; and H. F. O'Brien and C. H. Simon, representing the manufacturers of hydrants.

The Task Group has had two meetings—the first on July 24, 1952, and the second on September 26, 1952—with a considerable amount of subsequent discussion.

The subsequent discussion centered about the strength requirements of the operating mechanism of the hydrant. The phraseology in the 1940 edition of the hydrant specifications was not clear. On the other hand, it has appeared that hydrants which are kept in good working condition can be operated with a standard 15-in. wrench in both the opening and closing direction when only one person is handling the wrench.

The Foreword contains this paragraph:

> Hydrants produced under these specifications are required to meet a test of 200-ft-lb torque applied at the operating nut in both opening and closing directions. This torque is considered fully adequate to operate a hydrant which is in good working condition. Hydrants with barrels longer than 5-ft bury may, however, require special design.

Section 5.8.1 of the text of the specifications will read, in part:

> The design factor of safety of the operating mechanism shall be five, and shall be based on the foot-pounds torque required for the closing and opening of the individual hydrant at 150-psi working water pressure. Hydrants shall be capable of being opened or closed after being subjected to an operating torque of 200 ft-lb applied at the operating nut. The torque requirements apply only to hydrants of 5-ft bury and under.

The task group is in complete agreement concerning these details.

The revised text of the complete document has been submitted to the members of the Board for final approval by letter ballot.

Report on Publications

For the Year Ending December 31, 1952

A report on the publishing activities of the Association for the year ending Dec. 31, 1952, submitted to the AWWA Board of Directors on Jan. 19, 1953, by Eric F. Johnson, Asst. Secretary—Publications.

THE year 1952 was a boom year for all AWWA publications. The JOURNAL showed significant growth in overall size and in circulation, in technical articles and in advertising, and in income more even than expense. The first issue of the new two-part *Directory* exceeded expectations both in size and in advertising sold. Sales of reprints and specifications virtually doubled those of last year, and book sales far surpassed all estimates. Continued promotion and the growth of the Association in both membership and influence were the factors primarily responsible. A detailed report on the various publications follows:

1. The Journal

a. *Contents.* Total JOURNAL pages for the year were 2,608, which exceeded the original schedule by 112 and last year's total by 192. Increasing with the JOURNAL as a whole, the text section showed a gain of 142 pages, to reach a total of 1,218, and a gain of 27 articles, bringing their number up to 145. Of the year's articles, 24 were Association or other official documents and reports and 121 were technical papers, including 28 from the Annual Conference, 68 from Section Meetings, and 25 from other sources.

The news and advertising section continued to gain, too, increasing a total of 50 pages with the gain of 32 pages of paid advertising. Meanwhile, on the editorial pages facing advertising matter, the abstracts section was boosted to a total of 146 pages, equaling its highest level in the past 10 years.

The continuing large gains in advertising pages during the past few years have resulted in a progressive unbalancing of the JOURNAL contents, primarily because simultaneous large increases in printing costs have made it necessary to hold down overall size. To compensate for the consequent reduction of pages available for technical articles, a series of format changes, featured by the transfer of abstracts to the advertising section, was undertaken in 1948. Now, again, for a variety of reasons—including the certainty of increased prices, increased advertising, and an increase in the number of section papers available for publication in 1953—it has become necessary to make new efforts to reestablish the precedence of the text section. To this end, a new format for 1953 includes a limited program of "facing" advertisements, compensating for elimination of adjoining editorial matter by a position at the front of the JOURNAL, and further economies in the "Percolation and Runoff" material by reduction of type size in some sections, by

the use of two columns throughout, and by the more careful editing and screening of items used. This program will mean a return to the predominance of text pages, dividing the 2,640 pages scheduled for 1953 into 1,362 text and 1,278 advertising, compared to the 1,110 text and 1,530 advertising that would result from continuing the 1952 format. Stated in another way, the change will permit the use of the 1,362 text pages now considered necessary, for approximately $5,000 less than those pages would cost in the 1952 format.

b. *Cost.* Increases from 2,416 to 2,640 in number of pages, from 10,091 to 11,189 in average number of copies printed, from 188 to 197.4 in the 1943-based printing cost index, and from 191 to 196.9 in the paper rate index combined to increase overall JOURNAL costs almost exactly $10,000 over those of 1951, the 1952 total reaching $61,683.94. Expressed in costs per copy printed, these increases involved a change from 42.5 cents in 1951 to 45.9 cents in 1952, but the large increase in copies printed made it possible to hold the unit cost to the same $2.07 per 1,000 pages printed that prevailed in 1951.

A printing rate increase of 5 per cent in November 1952 to be followed by another of 2 per cent in September 1953, together with the scheduled increase of 32 pages in overall size of the JOURNAL for 1953, set the proposed budget for the year at a total of $68,000, almost 10 per cent higher than 1952 expense.

c. *Income.* JOURNAL income from all sources exceeded expectations. Although subscription sales showed only a slight gain, to $7,094.29, reprint income jumped from $3,664.24 in 1951 to $5,576.15 in 1952. Meanwhile advertising income was $85,146.50, compared with last January's estimate of $80,000 and a 1951 total of $72,639. Behind the large dollar gain was the 12.5 per cent increase in advertising rates applied during the year and a healthy gain in space sales from 847 pages in 1951 to 879 in 1952.

A further gain in space sales to bring the income level to $87,500 may be expected in 1953. As the rate increases already imposed and scheduled to be imposed during the year will mean that printing costs go up more than this, the percentage margin of advertising income over printing cost in 1953 is expected to be the lowest since 1942. For that reason, and because the paid circulation of the JOURNAL is already 15 per cent higher than it was when the last rate increase was approved, an increase in JOURNAL advertising rates of approximately 15 per cent, to become effective in January 1954, is indicated.

2. The Directory

With the November JOURNAL was issued the first section of the new two-part *Directory,* which included all the membership lists and the directory of Association committees. Held for publication in the 1953 section were the Constitution, By-Laws, and other Association information, the Buyers' Guide, the Directory of Consultants, and other incidental features. Also to be republished there are the committee lists, for, although it had been planned to include them only in the odd-year section of the *Directory,* the working convenience of the more current information has recommended publication annually.

Despite the reduction in size made possible by splitting the *Directory,* a 12 per cent increase in membership

entries over the 1950 edition offset some of the savings effected, so that the 1952 *Directory* totaled 256 pages, compared to the 320 of 1950. Higher printing and production costs, and an increase in copies printed from 11,100 to 12,130, were the factors responsible for pushing total cost upward from $7,905.23 in 1950 to $8,527.35 in 1952. The higher rates were also reflected in the unit cost per 1,000 pages, which rose from $2.20 in 1950 to $2.70 in 1952. Unit costs per copy, however, dropped from 71.2 cents to 70.3 cents gross and from 37.9 cents to 31 cents net after deducting advertising income.

Advertising income, which is expected to grow as the *Directory* becomes established as an annual publication, actually exceeded expectations, totaling $4,763.00 for 51 pages, compared to $3,679.50 for 45 pages in 1950. Preliminary announcement and contract forms for the 1953 edition have already been forwarded to Associate Members.

3. Specifications

During 1952, specifications for soda ash, aluminum sulfate, gate valves, steel pipe flanges, and short-body cast-iron fittings, and recommended procedures for painting elevated tanks and for sealing abandoned wells were approved and published in the JOURNAL. In addition, four sets of specifications, covering concrete pipe of two types and construction and repair of steel tanks, were materially revised, but not republished in full. All are now available in reprint form.

Not only sales of new specifications but also a tremendous increase in the day-to-day orders pushed income from these documents up to an unprecedented $7,428.68, more than twice the 1951 total of $3,603.74 and far above the budgeted $4,500. With early 1953 approval of the balance of the ASA A21 documents assured, this high level of sales should be maintained during the current year.

4. Journal Indexes

In 1952, 19 copies of the 1881–1939 index and 27 copies of the 1940–44 supplement were sold, slightly but not significantly fewer than in 1951. Stocks of these volumes on hand total 164 and 172, respectively.

No definite plans for the publication of a new consolidated index to cover the period from 1939 to the present have yet been completed. At present, however, the possibility of a 15-year supplement to cover the period 1940–54 is being considered. A volume to cover at least that period of time would appear to be the most useful for reference work.

5. Standard Methods

During 1952, 2,015 copies of the ninth edition of *Standard Methods for the Examination of Water and Sewage* were sold, requiring an additional small printing of the book and pushing total sales to approximately 19,500 copies. Total copies now in stock are 435, which may not be adequate until the tenth edition is issued.

Work on the manuscript of the tenth edition is now scheduled for completion by the end of March 1953, which will probably mean that the book can be issued early in 1954. At the present time, the recommended chemical determinations for the water section of the book are being styled, duplicated, and distributed by the Association staff for final review and approval.

6. Accounting Manual

Sales of the *Manual of Water Works Accounting* increased from 105 in 1951 to 152 in 1952, leaving a total of 579 copies in stock. The recent popularity of this 1938 book, which has seen its sales increase in each of the past 4 years, can be attributed primarily to continued promotion.

7. Survival and Retirement Book

During 1952, sales of *Survival and Retirement Experience With Water Works Facilities* also showed continued gains. A total of 162 copies were sold, compared with 118 in 1951 and only 50 in 1950. Stock on hand totals 257 bound copies and 1,000 unbound.

8. The Quest for Pure Water

Now 5 years old, *The Quest for Pure Water* continued in demand, with sales of 140 copies, compared with 149 in 1951. As this reduced the stock of bound copies to less than 6 months' supply, a new lot of 500 copies was bound, leaving approximately 500 unbound against future needs.

9. Water Quality and Treatment

As was expected, sales of the second edition of *Water Quality and Treatment* dropped during 1952. The total of 815 sold, however, considerably exceeded expectations, and orders from college bookstores gave promise of a continued steady demand for the book. The present stock of bound copies is 1,719, but approximately 4,800 unbound copies will be adequate to meet any demand that can be expected before a third edition is issued.

10. British Manual

Through an intensive direct-mail promotion handled by the British Institution of Water Engrs., AWWA, which acts as sole American sales agent for the *Manual of British Water Supply Practice,* filled orders for a total of 507 copies during 1952. Although the margin earned by AWWA on these transactions did little more than pay the cost of sales, the Association's handling of the book has made it available to American water works men at a saving of approximately $5.00 below what would have been the commercial price.

11. Willing Water

The bulletin, *Willing Water,* which has been the organ of the Association's public relations program for the past 7 years, is now generally considered another of AWWA's regular publications. Although its four issues during 1952 were most irregular in timing, plans for 1953 are to establish it on a regular bimonthly schedule and to use its pages for discussions of safety, civil defense, and other timely subjects, as well as for regular public relations coverage.

Board Action

The Board referred the consideration of a 1954 increase in advertising rates to the Executive and Finance Committees with power to act.

Report of the Audit of Association Funds

For the Year Ending December 31, 1952

To the Members of the American Water Works Association:

The By-Laws require that the Secretary have an audit made annually of the books of the Association.

The records for 1952 have been examined by the staff of Louis D. Blum & Co. The complete record of that examination follows:

Audits have been published in the JOURNAL annually. Since 1942 they have appeared in the March issues.

Respectfully submitted,

HARRY E. JORDAN
Secretary

January 22, 1953

TO THE AMERICAN WATER WORKS ASSOCIATION:

We have examined the balance sheet of the American Water Works Association as of December 31, 1952, and the related statements of income and surplus for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet as of December 31, 1952, and the related statements of income and surplus present fairly the financial position of the American Water Works Association at that date and the results of its operations for the year then ended in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed)

LOUIS D. BLUM & CO.
Certified Public Accountants

EXHIBIT A—Balance Sheet

December 31, 1952

Assets

Cash in Banks and on Hand		$ 35,969.70
Accounts Receivable:		
Advertising—Journal	$7,171.50	
Advertising—1952 Membership Directory	301.00	
Reprints	931.38	
Manual—Water Quality and Treatment	190.40	
Sundry specifications	799.44	
Other	227.43	9,621.15
Membership Dues		616.90
Accrued Interest on Bonds		567.33
Inventories:		
Paper stock	4,930.74	
Type metal	1,663.41	
Cumulative Index (165 copies)	198.00	
Quest for Pure Water—Baker	1,634.73	
Survival and Retirement Book	1,197.12	
Manual—Water Quality and Treatment	4,978.50	
Manual of Water Works Accounting	862.71	
Manual of British Water Supply Practice	334.80	
Sundry specifications	2,504.60	
Back issues—Journals—Vol. 1–44, inclusive (45,376 copies)	—*	
Back issues—Proceedings, 1881–1913, inclusive (251 copies)	—*	18,304.61
Office Equipment (less depreciation)		10,292.81
Investments at Cost (Schedule 1)		124,279.19
Deferred Expenses		3,168.47
Deposit—Airlines		425.00
Total Assets		$203,245.16

Liabilities and Surplus

Accounts Payable	$ 485.95
Membership Dues—Advance Payments	45,484.63
Unearned Subscriptions to Journal	3,367.80
Payable to American Water Works Association Pension System	30,000.00†
Reserve for Award Fund (McCord)	53.02
Senior Members Contributory Fund	229.50
Surplus, per Exhibit C	123,624.26
Total Liabilities and Surplus	$203,245.16

* Back issues of Journals and Proceedings are inventoried but no money values are assigned to them for balance sheet purposes inasmuch as the entire costs were charged off during the year of publication. The quantity shown is in accordance with a tabulation supplied by the Association's printer.

† Secured by assignment of the income of U.S. Savings Bonds, Series G, and maturity redemption value of such bonds in the amount of $30,000.

EXHIBIT A, Schedule 1—Investments

December 31, 1952

Description	Interest Rate %	Principal Amount	Cost	Quoted Market or Redemption Value Dec. 31, 1952
Foreign Securities (see notes):				
Province of Ontario	4	$ 1,000.00	$ 732.50	$ 1,077.50*
Canadian Victory Bonds	3	6,000.00	5,647.75	6,138.75†
Canadian Victory Bonds	3	2,000.00	2,000.00	1,970.00†
Hydro Electric Power Commission of Ontario	2¾	5,000.00	5,075.00	4,450.00†
Province of Ontario	3	2,000.00	2,022.50	1,861.25†
Hydro Electric Power Commission of Ontario	3	2,000.00	2,020.00	1,858.75†
Dominion of Canada, 9th Victory Loan	3	5,000.00	4,775.00	4,831.25†
United States Securities:				
U.S. Savings Bonds:				
Series G	2½	10,000.00	10,000.00	9,860.00‡§
Series G	2½	10,000.00	10,000.00	9,670.00‡§
Series G	2½	10,000.00	10,000.00	9,550.00‡§
Series G	2½	2,000.00	2,000.00	1,958.00‡
Series G	2½	5,000.00	5,000.00	4,880.00‡
Series G	2½	2,000.00	2,000.00	1,934.00‡
Series G	2½	10,000.00	10,000.00	9,640.00‡
Series G	2½	3,000.00	3,000.00	2,883.00‡
Series G	2½	10,000.00	10,000.00	9,550.00‡
Series G	2½	2,000.00	2,000.00	1,910.00‡
Series G	2½	5,000.00	5,000.00	4,760.00‡
Series G	2½	2,000.00	2,000.00	1,904.00‡
Series G	2½	7,500.00	7,500.00	7,102.50‡
Series G	2½	2,500.00	2,500.00	2,405.00‡
Series G	2½	1,000.00	1,000.00	969.00‡
U.S. Certificate of Indebtedness	1⅞	10,000.00	10,004.06	9,999.10
U.S. Certificate of Indebtedness	2	10,000.00	10,002.38	10,001.50
			$124,279.19	$121,163.60

* This security is payable in United States funds.

† These securities are payable in Canadian funds. Market value represents value in New York in United States funds.

‡ These amounts represent redemption value on Dec. 31, 1952.

§ Redemption value and income of these securities assigned to American Water Works Association Pension System.

EXHIBIT B—Statement of Income and Expenses

For the Year Ended December 31, 1952

Operating Income:

Annual dues	$ 92,657.34	
Advertising	85,134.00	
1952 Membership Directory	4,763.00	
Subscriptions to Journal	6,087.44	
Operating Income (carried forward)		$188,641.78

Operating Income (brought forward)		$188,641.78	
Convention registration fees		21,812.00	
Convention—other events		1,162.40	
Water and Sewage Works Manufacturers' Assn.		7,500.00	
Interest on investments		2,168.76	
John M. Goodell prize		75.00	
Miscellaneous interest income		10.61	
Total Operating Income			$221,370.55
Publication Income:			
Manual of Water Works Accounting		542.15	
Reprints		6,438.88	
Cumulative Index		59.80	
Membership Certificates		223.40	
Proceedings and Journals		1,194.26	
Quest for Pure Water—Baker		632.65	
Survival and Retirement Book		374.40	
Manual—Water Quality and Treatment		3,758.97	
British Water Works Practice Manual		2,610.90	
What Price Water Booklets		296.43	
Sundry specifications		8,459.66	
One-half of profit from sales of Standard Methods		2,979.88	
Total Publication Income			27,571.38
Total Income (carried forward)			248,941.93
Operating Expenses:			
Directors' and Executive Committee Meetings:			
Travel expense	$ 7,041.43		
Stenographic expense	159.50		
Executive committee meetings	36.00	$ 7,236.93	
Administrative Expenses:			
Rent	10,000.00		
Office supplies and services	12,085.20		
Membership promotion	35.46		
Pension—Secretary Emeritus	2,500.00		
Contribution to pension system	5,065.32		
Legal and accounting expenses	1,251.85		
General and special travel	2,651.38		
Federal activities	267.61	33,856.82	
Administrative Salaries		69,823.56	
Committee Expense		1,198.49	
Division and Section Expenses:			
Section—membership allotment	16,656.11		
Section—official travel	4,624.58		
Section—general expense	691.07	21,971.76	
Operating Expenses (carried forward)		$134,087.56	

TOTAL INCOME (brought forward)			$248,941.93
OPERATING EXPENSES (brought forward)		$134,087.56	
Journal:			
Printing	42,546.49		
Production	5,531.33		
Paper	13,875.57		
Abstractors	158.57		
1952 Membership Directory	8,527.35	70,639.31	
Convention:			
General	7,944.53		
Entertainment	11,455.52	19,400.05	
Membership Dues in Other Associations		530.50	
John M. Goodell Prize		75.00	
Depreciation of Office Equipment		1,469.60	
Miscellaneous Expenses		107.52	
TOTAL OPERATING EXPENSES		$226,309.54	
Cost of Publications Sold:			
Manual of Water Works Accounting	$ 320.86		
Reprints	4,894.17		
Cumulative Index	8.28		
Membership Certificates	184.29		
Proceedings and Journals	134.02		
Quest for Pure Water—Baker	336.68		
Survival and Retirement Book	131.86		
British Water Works Practice Manual	2,269.98		
Manual—Water Quality and Treatment	1,945.24		
What Price Water Booklets	26.01		
Sundry specifications	6,080.83	16,332.22	
Development Activities:			
Public relations	4,344.73		
Research—Compensation of Water Works Personnel	58.19		
Survey of Operating Data for 1950	5.15	4,408.07	
TOTAL EXPENSES			247,049.83
Net Income for the Year (transferred to Exhibit C)			$ 1,892.10

EXHIBIT C—SURPLUS FOR THE YEAR ENDED DECEMBER 31, 1952

Balance, January 1, 1952	$121,732.16
Add: Net income for the year, per Exhibit B	1,892.10
Balance, December 31, 1952, per Exhibit A	$123,624.26

American Water Works Association Pension System

BALANCE SHEET—DECEMBER 31, 1952

Assets

Cash in bank	$ 1,201.82
Accrued bond interest	416.25
Investments (Schedule 1)	73,000.00
TOTAL ASSETS	$74,618.07

Liabilities and Reserve for Future Benefits

Liability for refund of employees' contributions plus earned interest	$ 4,445.98
Reserve for future benefits	70,172.09
TOTAL LIABILITIES AND RESERVE	$74,618.07

SCHEDULE 1—INVESTMENTS, DECEMBER 31, 1952

Description	Interest Rate %	Principal	Maturity Date
Bonds Registered in Name of Administrative Committee:			
Series G	2½	$10,000.00*	1961
Series G	2½	10,000.00*	1962
Series G	2½	14,000.00*	1963
Series K	3	5,000.00†‡	1964
Series K	3	4,000.00‡§	1964
Bonds Registered in Name of Association and Assigned to Administrative Committee:			
Series G	2½	10,000.00	1953
Series G	2½	10,000.00	1956
Series G	2½	10,000.00	1958
		$73,000.00	

* Redemption value on Dec. 31, 1952: $32,651.00.
† Not redeemable until Jan. 1, 1953.
‡ Acquired in 1952.
§ Not redeemable until June 1, 1953.

STATEMENT OF RECEIPTS AND DISBURSEMENTS FOR THE YEAR 1952

Item	Cash	Reserve for Future Benefits	Liability for Refund of Employees' Contributions
Receipts:			
Association contributions	$5,065.32	$ 5,065.32	
Employees' contributions	1,498.45		$1,498.45
Interest on bonds	1,600.00	1,600.00	
Total	8,163.77	6,665.32	1,498.45
Disbursements:			
Investment in "K" bonds	9,000.00		
Refund of contributions plus interest	13.52		13.52
Audit and legal expense	50.00	50.00	
Office expenses	7.23	7.23	
Total	9,070.75	57.23	13.52
Excess of Cash Disbursements Over Receipts	906.98	6,608.09	1,484.93
Adjustments for Non-Cash Items:			
Interest credited to employees' accounts		(71.66)*	71.66
Interest accrued on bonds Jan. 1, 1952		(331.25)*†	
Interest accrued on bonds Dec. 31, 1952		416.25‡	
Total		13.34	71.66
Additions to accounts for year	(906.98)*	6,621.43	1,556.59
Balance, Jan. 1, 1952	2,108.80	63,550.66	2,889.39
Balance, Dec. 31, 1952	$1,201.82	$70,172.09	$4,445.98

* Deduction.
† Accrued interest receivable as per balance sheet Dec. 31, 1951.
‡ Accrued interest receivable as per balance sheet Dec. 31, 1952.

AWWA Membership Growth

Membership Statement—Year of 1952

	Active	Corporate	Munic. Serv. Subscriber	Associate	Honorary	Junior	Affiliate	Total
Total members, Dec. 31, 1951	7,156	818	134	341	34	47	53	8,583
Change of grade, 1952	17	—	—	—	3	−17	−3	
	7,173	818	134	341	37	30	50	8,583
Gains:								
New in 1952	869	69	26	19	—	20	2	1,005
Reinstated in 1952	59	5	—	2	—	—	—	66
	8,101	892	160	362	37	50	52	9,654
Losses:								
Resignations and deaths, 1952	−210	−15	—	−6	—	—	−1	−232
Dropped for nonpayment, 1952	−439	−45	−7	−8	—	− 4	−2	−505
TOTAL MEMBERS, Dec. 31, 1952	7,452	832	153	348	37	46	49	8,917
Net gain in 1952	296	14	19	7	3	− 1	−4	334

Comparative Statement—Gains and Losses—25-Year Period

Year	New	Reinstated	Resignations and Deaths	Suspended for Nonpayment of Dues	Gain or Loss	Total Members at End of Year
1928	203	36	99	126	14+	2,456
1929	314	25	118	130	91+	2,547
1930	501	39	122	134	284+	2,831
1931	203	22	123	216	114−	2,717
1932	117	22	169	297	327−	2,390
1933	168	56	159	234	169−	2,221
1934	271	66	86	122	129+	2,350
1935	565	42	85	190	332+	2,682
1936	311	53	104	218	42+	2,724
1937	515	86	122	139	340+	3,064
1938	520	59	144	140	295+	3,359
1939	578	64	122	179	351+	3,710
1940	514	58	113	212	247+	3,957
1941	480	92	116	236	220+	4,177
1942	570	59	132	233	264+	4,441
1943	769	88	130	198	529+	4,970
1944	734	92	140	171	515+	5,485
1945	543	56	111	235	253+	5,738
1946	816	79	168	324	403+	6,141
1947	933	74	143	349	515+	6,656
1948	847	81	207	347	374+	7,030
1949	1,083	75	196	323	639+	7,669
1950	852	58	128	421	361+	8,070
1951	1,090	63	199	441	513+	8,583
1952	1,005	66	232	505	334+	8,917

AWWA C100-52T
(Formerly 7C.1)

Tentative

Standard Specifications

for

CAST-IRON PRESSURE FITTINGS

American Water Works Association

New England Water Works Association

This document presents in slightly revised form the "special castings" portion of "Standard Specifications for Cast-Iron Water Pipes and Special Castings—7C.1-1908" which was adopted by AWWA on May 12, 1908. Although it has been superseded for new installations by various American Standards for cast-iron pipe and fittings (ASA specifications A21.2, A21.6, A21.8, and A21.10), it is still valid and useful as a basis for replacing fittings in distribution systems constructed according to the original 1908 specifications.

Certain revisions of the 1908 text approved by AWWA on Dec. 31, 1952, and by NEWWA on Jan. 22, 1953, are contained in the present document.

Price of reprint—40¢ per copy
Approximate date available—Apr. 30, 1953

AMERICAN WATER WORKS ASSOCIATION
Incorporated

521 Fifth Avenue, New York 17, N.Y.

Table of Contents

Latest Revisions to C100 (Formerly 7C.1–1908)

Specifications C100 were revised Dec. 31, 1952. The changes consist of:

1. Removal of the material on cast-iron pipe.
2. Revision of the tables of weights for cast-iron fittings.
3. Elimination of the old Type 1 reducer and Type 1 **Y** branch.
4. Changes in bell and spigot dimensions (Table 1).
5. Changes in offset design to give three offsets per pipe size instead of one (Table 4).
6. Larger dimensions for blowoff branches with manhole (Table 8) and for manhole pipe (Table 9).
7. Simplification and correction of illustrations, particularly Fig. 1, 6, 11, 12, and 13.
8. Miscellaneous additions (such as that of bell-and-bell combinations) and corrections.

These revisions have been incorporated into the text of the Second Edition, first published in March 1953. The text of the earlier edition thus becomes obsolete.

This printing contains all the revisions and changes summarized above.

Tentative Standard Specifications for

Cast-Iron Pressure Fittings

Sec. 1—Description of Fittings

The fittings shall be made with bell and spigot joints and shall conform, within the specified tolerances, to the dimensions given in the tables forming a part of these specifications.

For pipe 4–12 in., one class of fittings shall be furnished, made from Class D patterns. Spigot ends shall have reduced outside diameters as shown by Table 1 and shall taper back for a distance of 6 in.

For pipe 14–24 in., two classes of fittings shall be furnished—Class B, and Class D, on which the letters "B" and "D", respectively, shall be cast. For pipe 30–60 in., four classes of fittings—Classes A, B, C, and D, shall be furnished and they shall have cast on them the letter of the class to which they belong.

Classes A, B, C, and D fittings provide for the following working heads and pressures:

Class	Head *ft*	Pressure *psi*
A	100	43
B	200	86
C	300	130
D	400	173

The flanges on all manhole castings and manhole covers shall be faced and drilled as shown in the tables. The manufacturer shall furnish mild steel bolts with square heads, hexagon nuts and gaskets.

Sec. 2—Variation in Diameter

Sockets and spigots shall be tested with circular gages. Tolerances of fittings made from standard patterns are:

Size Range *in.*	Tolerance *in.*
4–16	± 0.12
18–24	± 0.15
30–42	± 0.20
48–60	± 0.24

Sec. 3—Variation in Thickness

The thickness tolerance for fittings with standard wall thickness of less than 1 in. shall be minus 0.12 in. The tolerance for fittings with standard wall thickness 1 in. and more shall be minus 0.15 in. An additional tolerance of 0.03 in. is permitted for spaces not exceeding 8 in. in length in any direction.

Sec. 4—Variation in Weight

The weight tolerance for 4–12 in. standard fittings is ± 10 per cent. For 14–60 in. fittings, the tolerance is ± 8 per cent. For bends and wyes, the tolerance is ± 12 per cent.

No weight shall be paid for that is in excess of the amount allowed by maximum tolerance. No fitting shall be accepted that weighs less than the amount allowed by minimum tolerance.

Sec. 5—Marking

Each fitting shall have cast, on the outside, the initials of the maker's name

and the class. As many as four special initials and the year may also be cast when required by the customer. The weight shall be painted conspicuously on each fitting.

Sec. 6—Quality of Iron

All fittings shall be made of cast iron of good quality. The metal of the castings shall be strong, tough, of even grain, and soft enough to drill and cut satisfactorily. The manufacturer shall have the right to make and break three bars from each heat and report the average results of the three tests.

Sec. 7—Tests of Material

At least one test bar of the metal used, 26 in. long by 2 in. wide and 1 in. thick, shall be made and tested from each heat. The bars, when placed flatwise upon supports 24 in. apart, and loaded in the center, shall support a load of 2,000 lb and show a deflection of not less than 0.30 in. before breaking. If preferred, tensile bars which will show a breaking point of not less than 20,000 psi shall be made.

Sec. 8—Quality of Castings

The fittings shall be smooth and free from defects of every nature which would make them unfit for the use for which they are intended. No plugging or filling will be allowed.

Sec 9—Cleaning and Inspection

All fittings shall be thoroughly cleaned and subjected to a careful inspection.

Sec. 10—Linings and Exterior Coatings

Any particular lining or coating which is to be applied to the fittings shall be specified in the agreement made at the time of purchase. Separate specifications for cement-mortar lining (ASA A21.4; also known as AWWA C104) have been provided as a part of specifications for pipe.

No fittings for water works service shall be furnished without protective coating unless specifically ordered by the purchaser.

Sec. 11—Weighing

The fittings shall be weighed under the supervision of the engineer before the application of any lining or coating other than hot or cold bituminous dip or paint. If desired by the engineer, the fittings shall be weighed after their delivery, and the weights so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weighmaster. Bids shall be submitted and a final settlement made upon the basis of a ton of 2,000 lb.

Sec. 12—Men and Material

The manufacturer shall provide all tools, testing machines, and labor necessary for the required testing, inspection and weighing at the foundry. If specified on the order, the manufacturer shall furnish the test results and a sworn statement that all of the tests have been made as specified.

Sec. 13—Power to Inspect

The engineer shall be at liberty at all times to inspect the material at the foundry, and the molding, casting, and coating of the fittings. All castings shall be subject to his inspection and approval, and he may reject any casting which is not in conformity with the specifications or drawings.

Sec. 14—Inspector to Report

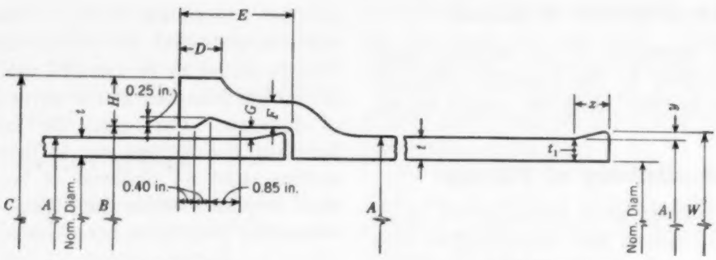
The inspector at the foundry shall report daily to the foundry office all fittings rejected, with the causes for rejection.

Sec. 15—Delivery of Fittings

All fittings must be delivered in all respects sound and conformable with these specifications. The inspection shall not relieve the manufacturer of his obligations under this section, and any defective fittings which may have passed the engineer at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for fittings found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the fittings not to injure the coating, and no material of any kind shall be placed inside the fittings at any time after they have been coated.

Sec. 16—Definition of "Engineer"

Wherever the word "engineer" is used herein it shall be understood to refer to the engineer or inspector acting for the purchaser and to his properly authorized agents, limited by the particular duties entrusted to them.



3-in. and 14- to 60-in. Spigots

14- to 12-in. Spigots

x and *y* Common to All Sizes

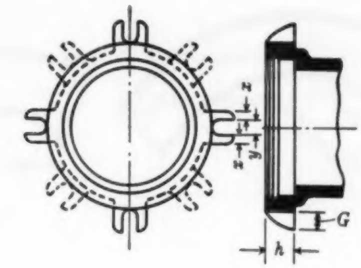
$x = \frac{3}{4}$ in. on 4-6 in.
$y = \frac{3}{16}$ in. on 4-12 in.

$x' = 1$ in. on 8-60 in.
$y = \frac{1}{4}$ in. on 14-60 in.

TABLE 1. Standard Dimensions of Bells and Spigots for Fittings

Size *in.*	Class	Dimensions—*in.*											
		A	A_1*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*t*	t_1*	*W*
3	D	3.96		4.66	7.26	1.25	3.50	0.65	0.35	1.30	0.48		4.34
4	D	5.00	4.90	5.70	8.30	1.50	4.00	0.65	0.40	1.30	0.52	0.47	5.28
6	D	7.10	7.00	7.80	10.60	1.50	4.00	0.70	0.40	1.40	0.55	0.50	7.38
8	D	9.30	9.18	10.00	13.00	1.50	4.00	0.75	0.41	1.50	0.60	0.54	9.56
10	D	11.40	11.25	12.10	15.30	1.50	4.00	0.80	0.42	1.60	0.68	0.60	11.63
12	D	13.50	13.35	14.20	17.60	1.50	4.00	0.85	0.42	1.70	0.75	0.68	13.73
14	B	15.30		16.10	19.50	1.50	4.00	0.85	0.40	1.70	0.66		15.80
14	D	15.65		16.45	20.05	1.50	4.00	0.90	0.40	1.80	0.82		16.15
16	B	17.40		18.40	22.00	1.75	4.00	0.90	0.50	1.80	0.70		17.90
16	D	17.80		18.80	22.60	1.75	4.00	1.00	0.50	1.90	0.89		18.30
18	B	19.50		20.50	24.30	1.75	4.00	0.95	0.50	1.90	0.75		20.00
18	D	19.92		20.92	25.12	1.75	4.00	1.05	0.50	2.10	0.96		20.42
20	B	21.60		22.60	26.60	1.75	4.00	1.00	0.50	2.00	0.80		22.10
20	D	22.06		23.06	27.66	1.75	4.00	1.15	0.50	2.30	1.03		22.56
24	B	25.80		26.80	31.00	2.00	4.00	1.05	0.50	2.10	0.89		26.30
24	D	26.32		27.32	32.32	2.00	4.00	1.25	0.50	2.50	1.16		26.82
30	A	31.74		32.74	37.34	2.00	4.50	1.15	0.50	2.30	0.88		32.24
30	B	32.00		33.00	37.60	2.00	4.50	1.15	0.50	2.30	1.03		32.50
30	C	32.40		33.40	38.60	2.00	4.50	1.32	0.50	2.60	1.20		32.90
30	D	32.74		33.74	39.74	2.00	4.50	1.50	0.50	3.00	1.37		33.24
36	A	37.96		38.96	43.96	2.00	4.50	1.25	0.50	2.50	0.99		38.46
36	B	38.30		39.30	44.90	2.00	4.50	1.40	0.50	2.80	1.15		38.80
36	C	38.70		39.70	45.90	2.00	4.50	1.60	0.50	3.10	1.36		39.20
36	D	39.16		40.16	46.96	2.00	4.50	1.80	0.50	3.40	1.58		39.66
42	A	44.20		45.20	50.80	2.00	5.00	1.40	0.50	2.80	1.10		44.70
42	B	44.50		45.50	51.50	2.00	5.00	1.50	0.50	3.00	1.28		45.00
42	C	45.10		46.10	52.90	2.00	5.00	1.75	0.50	3.40	1.54		45.60
42	D	45.58		46.58	54.18	2.00	5.00	1.95	0.50	3.80	1.78		46.08
48	A	50.50		51.50	57.50	2.00	5.00	1.50	0.50	3.00	1.26		51.00
48	B	50.80		51.80	58.40	2.00	5.00	1.65	0.50	3.30	1.42		51.30
48	C	51.40		52.40	60.00	2.00	5.00	1.95	0.50	3.80	1.71		51.90
48	D	51.98		52.98	61.38	2.00	5.00	2.20	0.50	4.20	1.96		52.48
54	A	56.66		57.66	64.06	2.25	5.50	1.60	0.50	3.20	1.35		57.16
54	B	57.10		58.10	65.30	2.25	5.50	1.80	0.50	3.60	1.55		57.60
54	C	57.80		58.80	66.80	2.25	5.50	2.15	0.50	4.00	1.90		58.30
54	D	58.40		59.40	68.20	2.25	5.50	2.45	0.50	4.40	2.23		58.90
60	A	62.80		63.80	70.60	2.25	5.50	1.70	0.50	3.40	1.39		63.30
60	B	63.40		64.40	71.80	2.25	5.50	1.90	0.50	3.70	1.67		63.90
60	C	64.20		65.20	73.60	2.25	5.50	2.25	0.50	4.20	2.00		64.70
60	D	64.82		65.82	75.22	2.25	5.50	2.60	0.50	4.70	2.38		65.32

* For sizes 3 in. and 14–60 in., $A_1 = A$ and $t_1 = t$.



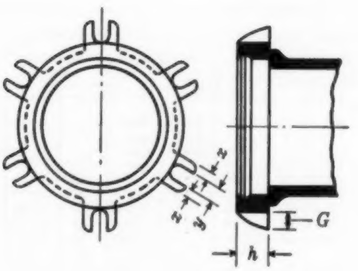


TABLE 2. Standard Lugs

Nominal Diameter Outlet *in.*	Number of Lugs	Approx. Weight, Bell Lugs *lb*	Approx. Weight, Spigot Lugs *lb*	Nominal Diameter Outlet *in.*	Number of Lugs	Approx. Weight, Bell Lugs *lb*	Approx. Weight, Spigot Lugs *lb*
12	4	30	45	30	6	80	125
14	4	30	45	36	6	85	135
16	6	45	70	42	8	130	200
18	6	50	75	48	8	130	210
20	6	50	75	54	8	145	230
24	6	50	80	60	8	150	250

Two pairs of lugs are placed on the vertical axis of each bell, the others at equal distances around circumference. As there are only six lugs on fittings in the 16–36-in. size range, purchasers should furnish a sketch showing location of lugs. On spigot end of pipe, unless otherwise specified, lug faces are located 21 in. from end of spigot. This dimension varies for fittings. h is equal depth of bell on all sizes.

G equals 2.50 in., x equals 1.25 in., y equals 1.63 in. for 12 to 24 in. inclusive.

G equals 3.00 in., x equals 1.50 in., y equals 2.00 in. for 30 to 60 in. inclusive.

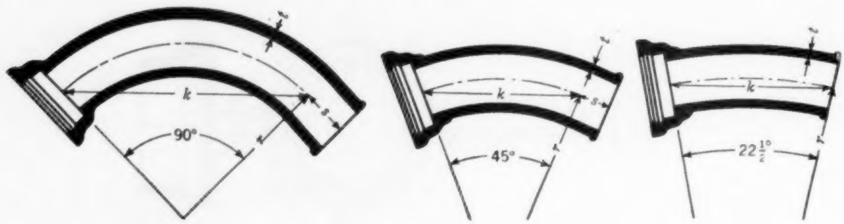


TABLE 3. Standard Bends

¼ Bends (90°)						
Size *in.*	Class	Dimensions* *in.*			Weight† *lb*	
		t	*r*	*k*	Bell and Spigot	Bell and Bell
4	D	0.52	16	22.60	90	100
6	D	0.55	16	22.60	135	145
8	D	0.60	16	22.60	200	200
10	D	0.68	16	22.60	285	275
12	D	0.75	16	22.60	365	350
14	B	0.66	18	25.50	410	400
14	D	0.82	18	25.50	495	470
16	B	0.70	24	34.00	590	590
16	D	0.89	24	34.00	740	720
18	B	0.75	24	34.00	705	700
18	D	0.96	24	34.00	895	870
20	B	0.80	24	34.00	835	825
20	D	1.03	24	34,00	1,070	1,045
24	B	0.89	30	42.40	1,275	1,255
24	D	1.16	30	42.40	1,665	1,625
30	A	0.88	36	50.90	1,820	1,850
30	B	1.03	36	50.90	2,090	2,075
30	C	1.20	36	50.90	2,450	2,430
30	D	1.37	36	50.90	2,825	2,820
36	A	0.99	48	67.90	3,000	3,025
36	B	1.15	48	67.90	3,500	3,525
36	C	1.36	48	67.90	4,145	4,155
36	D	1.58	48	67.90	4,830	4,835

⅛ Bends (45°)							$\frac{1}{16}$ Bends (22½°)			
Size *in.*	Class	Dimensions* *in.*			Weight† *lb*		Dimensions* *in.*		Weight† *lb*	
		t	*r*	*k*	Bell and Spigot	Bell and Bell	*r*	*k*	Bell and Spigot	Bell and Bell
4	D	0.52	24	18.40	75	90	48	18.70	75	90
6	D	0.55	24	18.40	110	125	48	18.70	110	125
8	D	0.60	24	18.40	155	180	48	18.70	155	180
10	D	0.68	24	18.40	210	240	48	18.70	210	240
12	D	0.75	24	18.40	270	305	48	18.70	270	305
14	B	0.66	36	27.60	365	400	72	28.10	315	400
14	D	0.82	36	27.60	440	475	72	28.10	380	475
16	B	0.70	36	27.60	445	500	72	28.10	385	500
16	D	0.89	36	27.60	550	605	72	28.10	480	605
18	B	0.75	36	27.60	555	590				
18	D	0.96	36	27.60	665	730	72	28.10	460	590
							72	28.10	580	730
20	B	0.80	48	36.70	755	825	96	37.50	670	825
20	D	1.03	48	36.70	965	1,045	96	37.50	860	1,045
24	B	0.89	60	45.90	1,165	1,255	120	46.80	1,055	1,255
24	D	1.16	60	45.90	1,520	1,625	120	46.80	1,375	1,625
30	A	0.88	60	45.90	1,480	1,645	120	46.80	1,345	1,645
30	B	1.03	60	45.90	1,690	1,830	120	46.80	1,530	1,830
30	C	1.20	60	45.90	1,980	2,145	120	46.80	1,795	2,145
30	D	1.37	60	45.90	2,285	2,490	120	46.80	2,075	2,490
36	A	0.99	90	68.90	2,500	2,885	180	70.20	2,500	2,885
36	B	1.15	90	68.90	2,920	3,360	180	70.20	2,920	3,360
36	C	1.36	90	68.90	3,450	3,960	180	70.20	3,450	3,960
36	D	1.58	90	68.90	4,020	4,605	180	70.20	4,020	4,605
42	A	1.10	90	68.90	3,280	3,820	180	70.20	3,280	3,820
42	B	1.28	90	68.90	3,785	4,370	180	70.20	3,785	4,370
42	C	1.54	90	68.90	4,580	5,280	180	70.20	4,580	5,280
42	D	1.78	90	68.90	5,315	6,115	180	70.20	5,315	6,115
48	A	1.26	90	68.90	4,250	4,905	180	70.20	4,250	4,905
48	B	1.42	90	68.90	4,800	5,545	180	70.20	4,800	5,545
48	C	1.71	90	68.90	5,815	6,710	180	70.20	5,815	6,710
48	D	1.96	90	68.90	6,715	7,755	180	70.20	6,715	7,755
54	A	1.35	90	68.90	5,180	6,025	180	70.20	5,180	6,025
54	B	1.55	90	68.90	5,975	6,960	180	70.20	5,975	6,960
54	C	1.90	90	68.90	7,330	8,510	180	70.20	7,330	8,510
54	D	2.23	90	68.90	8,635	10,020	180	70.20	8,635	10,020
60	A	1.39	90	68.90	5,960	6,975	180	70.20	5,960	6,975
60	B	1.67	90	68.90	7,110	8,245	180	70.20	7,110	8,245
60	C	2.00	90	68.90	8,585	9,970	180	70.20	8,585	9,970
60	D	2.38	90	68.90	10,230	11,870	180	70.20	10,230	11,870

* For ¼ bends, S in the 4- and 6-in. sizes equals 8 in.; in the 8-in. size, S = 10 in.; and in the 10–36-in. size range, S = 12 in. For ⅛ bends, S = 6 in. in the 4–30-in. sizes. For $\frac{1}{16}$ bends, S = 6 in. in the 4–12-in. sizes.

† All weights are rounded out to the nearest 5-lb multiple.

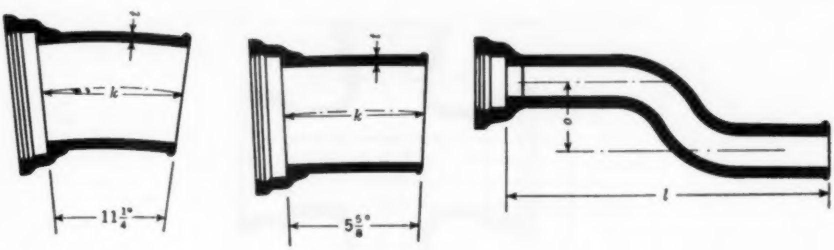


TABLE 4. Standard Bends and Offsets

Size *in.*	Class	$\frac{1}{32}$ Bends (11¼°) Dimensions *in.*			$\frac{1}{32}$ Bends (11¼°) Weight* *lb*		$\frac{1}{64}$ Bends (5⅝°) Dimensions *in.*		$\frac{1}{64}$ Bends (5⅝°) Weight* *lb*	
		t	*r*	*k*	Bell and Spigot	Bell and Bell	*r*	*k*	Bell and Spigot	Bell and Bell
4	D	0.52	120	23.52	70	95				
6	D	0.55	120	23.52	105	140				
8	D	0.60	120	23.52	150	200				
10	D	0.68	120	23.52	205	265				
12	D	0.75	120	23.52	260	340				
14	B	0.66	180	35.28	375	455				
14	D	0.82	180	35.28	450	545				
16	B	0.70	180	35.28	455	565				
16	D	0.89	180	35.28	565	695				
18	B	0.75	180	35.28	540	670				
18	D	0.96	180	35.28	685	835				
20	B	0.80	240	47.05	800	955	480	47.10	800	955
20	D	1.03	240	47.05	1,030	1,215	480	47.10	1,030	1,215
24	B	0.89	240	47.05	1,060	1,255	480	47.10	1,060	1,255
24	D	1.16	240	47.05	1,375	1,620	480	47.10	1,375	1,620
30	A	0.88	240	47.05	1,345	1,640	480	47.10	1,345	1,640
30	B	1.03	240	47.05	1,530	1,830	480	47.10	1,530	1,830
30	C	1.20	240	47.05	1,795	2,145	480	47.10	1,795	2,145
30	D	1.37	240	47.05	2,075	2,490	480	47.10	2,075	2,490
36	A	0.99	240	47.05	1,795	2,180	480	47.10	1,795	2,180
36	B	1.15	240	47.05	2,095	2,540	480	47.10	2,095	2,540
36	C	1.36	240	47.05	2,470	2,980	480	47.10	2,470	2,980
36	D	1.58	240	47.05	2,875	3,460	480	47.10	2,875	3,460
42	A	1.10	240	47.05	2,370	2,905	480	47.10	2,370	2,905
42	B	1.28	240	47.05	2,720	3,305	480	47.10	2,720	3,305
42	C	1.54	240	47.05	3,290	3,985	480	47.10	3,290	3,985
42	D	1.78	240	47.05	3,815	4,615	480	47.10	3,815	4,615
48	A	1.26	240	47.05	3,055	3,715	480	47.10	3,055	3,715
48	B	1.42	240	47.05	3,455	4,195	480	47.10	3,450	4,195
48	C	1.71	240	47.05	4,180	5,075	480	47.10	4,180	5,075
48	D	1.96	240	47.05	4,825	5,870	480	47.10	4,825	5,870
54	A	1.35	240	47.05	3,740	4,585	480	47.10	3,740	4,585
54	B	1.55	240	47.05	4,315	5,305	480	47.10	4,315	5,305
54	C	1.90	240	47.05	5,285	6,470	480	47.10	5,285	6,470
54	D	2.23	240	47.05	6,225	7,610	480	47.10	6,225	7,610
60	A	1.39	240	47.05	4,320	5,330	480	47.10	4,320	5,330
60	B	1.67	240	47.05	5,125	6,260	480	47.10	5,125	6,260
60	C	2.00	240	47.05	6,195	7,580	480	47.10	6,195	7,580
60	D	2.38	240	47.05	7,370	9,015	480	47.10	7,370	9,015

Offsets Size *in.*	Class	Dimensions *in.*		Weight *lb*
		O	*L*	
4	D	6	27	80
4	D	12	30	90
4	D	18	38	110
6	D	6	28	120
6	D	12	34	145
6	D	18	41	175
8	D	6	29	180
8	D	12	36	220
8	D	18	43	260
10	D	6	30	245
10	D	12	38	305
10	D	18	46	365
12	D	6	34	350
12	D	12	45	450
12	D	18	56	550
14	B	6	35	375
14	B	12	46	475
14	B	18	57	580
14	D	6	35	455
14	D	12	46	580
14	D	18	57	710
16	B	6	35	460
16	B	12	48	600
16	B	18	58	710
16	D	6	35	570
16	D	12	48	750
16	D	18	58	895

* All weights are rounded out to the nearest 5-lb multiple.

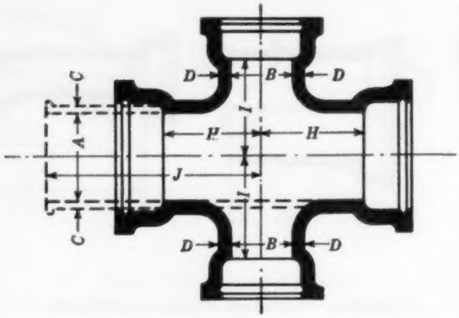


TABLE 5. Standard Tees and Crosses

Nominal Diam. (A × B) *in.*	Class	Dimensions—*in.*			Weight*—*lb*			
					Tees		Crosses	
		H	*J*	*I*	2 Bells	3 Bells	3 Bells	4 Bells
4×3	D	11	23	11	120	125	150	155
4×4	D	11	23	11	130	130	170	170
6×3	D	12	24	12	175	170	205	200
6×4	D	12	24	12	180	180	220	220
6×6	D	12	24	12	200	200	260	255
8×4	D	13	25	13	250	250	290	290
8×6	D	13	25	13	270	265	325	325
8×8	D	13	25	13	290	285	370	370
10×4	D	14	26	14	340	330	380	370
10×6	D	14	26	14	360	350	415	405
10×8	D	14	26	14	380	370	455	445
10×10	D	14	26	14	405	390	505	495
12×4	D	15	27	15	445	425	485	465
12×6	D	15	27	15	460	440	515	495
12×8	D	15	27	15	485	465	560	540
12×10	D	15	27	15	505	495	610	590
12×12	D	15	27	15	535	515	665	645
14×4	B	16	28	16	495	485	535	525
14×4	D	16	28	16	595	570	635	610
14×6	B	16	28	16	515	505	570	560
14×6	D	16	28	16	610	585	665	640
14×8	B	16	28	16	540	525	620	610
14×8	D	16	28	16	635	610	710	685
14×10	B	16	28	16	560	555	670	660
14×10	D	16	28	16	655	630	760	730

* All weights are rounded out to the nearest 5-lb multiple.

TABLE 5. Standard Tees and Crosses (continued)

Nominal Diam. (A×B) in.	Class	Dimensions—in.			Weight*—lb			
					Tees		Crosses	
		H	J	I	2 Bells	3 Bells	3 Bells	4 Bells
14×12	B	16	28	16	590	580	730	720
14×12	D	16	28	16	680	655	810	785
14×14	B	16	28	16	600	590	745	740
14×14	D	16	28	16	725	695	890	860
16×4	B	17	29	17	620	615	660	655
16×4	D	17	29	17	765	740	800	780
16×6	B	17	29	17	635	630	690	690
16×6	D	17	29	17	775	755	830	805
16×8	B	17	29	17	660	655	740	735
16×8	D	17	29	17	800	775	875	855
16×10	B	17	29	17	685	680	790	785
16×10	D	17	29	17	825	800	925	900
16×12	B	17	29	17	710	710	845	840
16×12	D	17	29	17	850	825	975	950
16×14	B	17	29	17	720	715	860	860
16×14	D	17	29	17	885	860	1,045	1,020
16×16	B	17	29	17	760	755	940	940
16×16	D	17	29	17	935	915	1,150	1,125
18×4	B	18	30	18	755	745	795	785
18×4	D	18	30	18	945	915	985	955
18×6	B	18	30	18	770	765	830	820
18×6	D	18	30	18	955	925	1,010	980
18×8	B	18	30	18	795	785	870	865
18×8	D	18	30	18	980	950	1,055	1,025
18×10	B	18	30	18	820	810	920	915
18×10	D	18	30	18	1,005	975	1,100	1,070
18×12	B	18	30	18	845	835	975	965
18×12	D	18	30	18	1,030	1,000	1,150	1,125
18×14	B	18	30	18	850	845	990	985
18×14	D	18	30	18	1,055	1,025	1,210	1,180
18×16	B	18	30	18	885	880	1,060	1,050
18×16	D	18	30	18	1,105	1,075	1,305	1,275
18×18	B	18	30	18	925	915	1,135	1,130
18×18	D	18	30	18	1,155	1,125	1,405	1,375
20×4	B	19	31	19	910	900	950	940
20×4	D	19	31	19	1,160	1,130	1,195	1,170
20×6	B	19	31	19	930	915	985	975
20×6	D	19	31	19	1,175	1,145	1,225	1,200

* All weights are rounded out to the nearest 5-lb multiple.

TABLE 5. **Standard Tees and Crosses** (continued)

Nominal Diam. (A × B) in.	Class	Dimensions—in.			Weight*—lb			
					Tees		Crosses	
		H	J	I	2 Bells	3 Bells	3 Bells	4 Bells
20×8	B	19	31	19	950	940	1,030	1,020
20×8	D	19	31	19	1,195	1,165	1,265	1,240
20×10	B	19	31	19	970	965	1.075	1.065
20×10	D	19	31	19	1,215	1,185	1,310	1,280
20×12	B	19	31	19	1,000	990	1,125	1,115
20×12	D	19	31	19	1,240	1,210	1,355	1,330
20×14	B	19	31	19	1,010	995	1,145	1,130
20×14	D	19	31	19	1,270	1,240	1,420	1,390
20×16	B	19	31	19	1,040	1,030	1,215	1,200
20×16	D	19	31	19	1,315	1,290	1,515	1,485
20×18	B	19	31	19	1,075	1,065	1,280	1,265
20×18	D	19	31	19	1,360	1,330	1,600	1,570
20×20	B	19	31	19	1,115	1,105	1,360	1,350
20×20	D	19	31	19	1,420	1,390	1,720	1,690
24×6	B	21	33	21	1,280	1,260	1,335	1,315
24×6	D	21	33	21	1,655	1,615	1,705	1,665
24×8	B	21	33	21	1,305	1,280	1,380	1,355
24×8	D	21	33	21	1,675	1,630	1,745	1,705
24×10	B	21	33	21	1,325	1,305	1,430	1,410
24×10	D	21	33	21	1,695	1,650	1,785	1,745
24×12	B	21	33	21	1,350	1,330	1,475	1,450
24×12	D	21	33	21	1,715	1,675	1,825	1,785
24×14	B	21	33	21	1,355	1,335	1,485	1,460
24×14	D	21	33	21	1,745	1,700	1,885	1,845
24×16	B	21	33	21	1,390	1,370	1,550	1,530
24×16	D	21	33	21	1,785	1,745	1,975	1,930
24×18	B	21	33	21	1,420	1,395	1,610	1,585
24×18	D	21	33	21	1,825	1,780	2,045	2,005
24×20	B	21	33	21	1,455	1,430	1,685	1,660
24×20	D	21	33	21	1,880	1,835	2,155	2,110
24×24	B	21	33	21	1,530	1,505	1,840	1,815
24×24	D	21	33	21	1,985	1,945	2,370	2,325
30×6	A	13	25	24	1,290	1,320	1,350	1,375
30×6	B	13	25	24	1,450	1,430	1,505	1,485
30×6	C	13	25	24	1,690	1,670	1,745	1,725
30×6	D	13	25	24	1,945	1,935	1,995	1,985
30×8	A	14	26	24	1,365	1,390	1,445	1,470
30×8	B	14	26	24	1,525	1,505	1,600	1,580
30×8	C	14	26	24	1,775	1,755	1,850	1,830
30×8	D	14	26	24	2,040	2,030	2,110	2,100

* All weights are rounded out to the nearest 5-lb multiple.

TABLE 5. Standard Tees and Crosses (continued)

Nominal Diam. ($A \times B$) *in.*	Class	Dimensions—*in.*			Weight*—*lb*			
					Tees		Crosses	
		H	*J*	*I*	2 Bells	3 Bells	3 Bells	4 Bells
30×10	A	15	27	24	1,430	1,460	1,535	1,560
30×10	B	15	27	24	1,605	1,585	1,705	1,685
30×10	C	15	27	24	1,865	1,840	1,955	1,935
30×10	D	15	27	24	2,135	2,125	2,220	2,210
30×12	A	15	27	24	1,460	1,485	1,585	1,615
30×12	B	15	27	24	1,630	1,610	1,750	1,730
30×12	C	15	27	24	1,885	1,865	2,000	1,975
30×12	D	15	27	24	2,155	2,145	2,260	2,250
30×14	A	18	30	26	1,625	1,650	1,775	1,800
30×14	B	18	30	26	1,815	1,795	1,960	1,940
30×14	C	18	30	26	2,135	2,110	2,300	2,280
30×14	D	18	30	26	2,430	2,420	2,590	2,575
30×16	A	19	31	26	1,710	1,735	1,895	1,920
30×16	B	19	31	26	1,910	1,890	2,085	2,065
30×16	C	19	31	26	2,250	2,225	2,460	2,435
30×16	D	19	31	26	2,555	2,540	2,755	2,745
30×18	A	20	34	26	1,840	1,815	2,060	2,035
30×18	B	20	34	26	2,050	1,975	2,260	2,185
30×18	C	20	34	26	2,425	2,335	2,680	2,590
30×18	D	20	34	26	2,745	2,655	2,990	2,900
30×20	A	21	36	26	1,945	1,905	2,205	2,160
30×20	B	21	36	26	2,170	2,070	2,420	2,315
30×20	C	21	36	26	2,580	2,455	2,890	2,770
30×20	D	21	36	26	2,910	2,785	3,205	3,075
30×24	A	23	38	26	2,130	2,080	2,470	2,425
30×24	B	23	38	26	2,365	2,255	2,680	2,575
30×24	C	23	38	26	2,825	2,700	3,250	3,130
30×24	D	23	38	26	3,165	3,040	3,560	3,435
30×30	A	26	43	26	2,445	2,355	2,920	2,825
30×30	B	26	43	26	2,765	2,600	3,260	3,100
30×30	C	26	43	26	3,245	3,055	3,825	3,635
30×30	D	26	43	26	3,745	3,545	4,425	4,225
36×8	A	14	26	27	1,785	1,805	1,865	1,885
36×8	B	14	26	27	2,070	2,090	2,140	2,165
36×8	C	14	26	27	2,420	2,430	2,490	2,500
36×8	D	14	26	27	2,800	2,795	2,865	2,865
36×10	A	15	27	27	1,875	1,895	1,970	1,990
36×10	B	15	27	27	2,165	2,190	2,255	2,280
36×10	C	15	27	27	2,525	2,535	2,615	2,625
36×10	D	15	27	27	2,920	2,920	3,000	3,000

* All weights are rounded out to the nearest 5-lb multiple.

TABLE 5. Standard Tees and Crosses (continued)

Nominal Diam. (A×B) in.	Class	Dimensions—in.			Weight*—lb			
					Tees		Crosses	
		H	J	I	2 Bells	3 Bells	3 Bells	4 Bells
36×12	A	16	28	27	1,960	1,985	2,085	2,105
36×12	B	16	28	27	2,260	2,285	2,375	2,400
36×12	C	16	28	27	2,635	2,645	2,745	2,755
36×12	D	16	28	27	3,040	3,040	3,140	3,140
36×14	A	18	30	29	2,110	2,130	2,255	2,275
36×14	B	18	30	29	2,430	2,455	2,565	2,590
36×14	C	18	30	29	2,860	2,865	3,020	3,025
36×14	D	18	30	29	3,295	3,295	3,435	3,435
36×16	A	19	31	29	2,210	2,230	2,390	2,410
36×16	B	19	31	29	2,540	2,560	2,705	2,730
36×16	C	19	31	29	3,000	3,005	3,195	3,205
36×16	D	19	31	29	3,440	3,440	3,625	3,625
36×18	A	20	34	29	2,370	2,325	2,580	2,535
36×18	B	20	34	29	2,715	2,665	2,915	2,860
36×18	C	20	34	29	3,215	3,135	3,455	3,375
36×18	D	20	34	29	3,690	3,585	3,920	3,810
36×20	A	21	36	29	2,505	2,425	2,750	2,670
36×20	B	21	36	29	2,865	2,775	3,095	3,000
36×20	C	21	36	29	3,405	3,275	3,695	3,565
36×20	D	21	36	29	3,890	3,730	4,160	4,000
36×24	A	23	38	29	2,710	2,630	3,025	2,950
36×24	B	23	38	29	3,080	2,990	3,375	3,285
36×24	C	23	38	29	3,685	3,560	4,080	3,950
36×24	D	23	38	29	4,190	4,030	4,545	4,385
36×30	A	26	43	29	3,075	2,930	3,500	3,360
36×30	B	26	43	29	3,535	3,370	3,980	3,815
36×30	C	26	43	29	4,170	3,955	4,685	4,470
36×30	D	26	43	29	4,850	4,585	5,445	5,180
36×36	A	29	46	29	3,430	3,290	4,020	3,875
36×36	B	29	46	29	3,995	3,825	4,675	4,510
36×36	C	29	46	29	4,705	4,490	5,490	5,275
36×36	D	29	46	29	5,465	5,200	6,365	6,100
42×12	A	16	28	30	2,545	2,615	2,660	2,735
42×12	B	16	28	30	2,895	2,935	3,005	3,045
42×12	C	16	28	30	3,470	3,505	3,565	3,605
42×12	D	16	28	30	3,990	4,030	4,080	4,120
42×14	A	18	30	32	2,735	2,805	2,870	2,945
42×14	B	18	30	32	3,110	3,150	3,235	3,275
42×14	C	18	30	32	3,750	3,785	3,895	3,930
42×14	D	18	30	32	4,305	4,345	4,440	4,475

* All weights are rounded out to the nearest 5-lb multiple.

TABLE 5. Standard Tees and Crosses (continued)

Nominal Diam. ($A \times B$) *in.*	Class	Dimensions—*in.*			Weight*—*lb*			
					Tees		Crosses	
		H	*J*	*I*	2 Bells	3 Bells	3 Bells	4 Bells
42×16	A	19	31	32	2,850	2,920	3,020	3,090
42×16	B	19	31	32	3,235	3,280	3,395	3,435
42×16	C	19	31	32	3,910	3,945	4,095	4,135
42×16	D	19	31	32	4,485	4,520	4,650	4,690
42×18	A	20	34	32	3,045	3,035	3,245	3,230
42×18	B	20	34	32	3,455	3,400	3,640	3,580
42×18	C	20	34	32	4,180	4,100	4,405	4,325
42×18	D	20	34	32	4,790	4,690	4,990	4,890
42×20	A	21	36	32	3,205	3,150	3,435	3,380
42×20	B	21	36	32	3,635	3,525	3,850	3,740
42×20	C	21	36	32	4,405	4,265	4,675	4,535
42×20	D	21	36	32	5,040	4,870	5,280	5,110
42×24	A	23	38	32	3,430	3,380	3,725	3,675
42×24	B	23	38	32	3,885	3,780	4,160	4,050
42×24	C	23	38	32	4,730	4,595	5,090	4,950
42×24	D	23	38	32	5,390	5,220	5,705	5,535
42×30	A	26	43	32	3,865	3,730	4,260	4,120
41×30	B	26	43	32	4,385	4,205	4,785	4,605
42×30	C	26	43	32	5,310	5,050	5,770	5,510
43×30	D	26	43	32	6,155	5,845	6,685	6,375
42×36	A	29	46	32	4,250	4,115	4,780	4,645
42×36	B	29	46	32	4,910	4,705	5,520	5,315
42×36	C	29	46	32	5,885	5,630	6,575	6,315
42×36	D	29	46	32	6,815	6,510	7,600	7,295
42×42	A	32	49	32	4,745	4,610	5,515	5,380
42×42	B	32	49	32	5,440	5,235	6,290	6,085
42×42	C	32	49	32	6,565	6,310	7,570	7,315
42×42	D	32	49	32	7,595	7,285	8,740	8,430
48×12	A	17	29	33	3,345	3,395	3,455	3,505
48×12	B	17	29	33	3.760	3,815	3,865	3,920
48×12	C	17	29	33	4,520	4,585	4,610	4,675
48×12	D	17	29	33	5,195	5,280	5,275	5,355
48×14	A	18	30	35	3,475	3,520	3,600	3,650
48×14	B	18	30	35	3,900	3,955	4,020	4,075
48×14	C	18	30	35	4,710	4,775	4,845	4,905
48×14	D	18	30	35	5,400	5,485	5,525	5,610
48×16	A	19	31	35	3,615	3,660	3,775	3,820
48×16	B	19	31	35	4,050	4,105	4,200	4,255
48×16	C	19	31	35	4,900	4,960	5,070	5,135
48×16	D	19	31	35	5,615	5,700	5,770	5,855

* All weights are rounded out to the nearest 5-lb multiple.

TABLE 5. Standard Tees and Crosses (continued)

Nominal Diam. (*A*×*B*) *in.*	Class	Dimensions—*in.*			Weight*—*lb*			
					Tees		Crosses	
		H	*J*	*I*	2 Bells	3 Bells	3 Bells	4 Bells
48×18	A	20	34	35	3,860	3,795	4,040	3,980
48×18	B	20	34	35	4,320	4,255	4,490	4,420
48×18	C	20	34	35	5,230	5,145	5,435	5,350
48×18	D	20	34	35	5,990	5,900	6,170	6,085
48×20	A	21	36	35	4,055	3,935	4,265	4,145
48×20	B	21	36	35	4,540	4,405	4,735	4,605
48×20	C	21	36	35	5,500	5,335	5,745	5,585
48×20	D	21	36	35	6,285	6,110	6,505	6,330
48×24	A	23	38	35	4,330	4,210	4,595	4,475
48×24	B	23	38	35	4,830	4,700	5,080	4,945
48×24	C	23	38	35	5,875	5,720	6,205	6,045
48×24	D	23	38	35	6,700	6,520	6,985	6,805
48×30	A	26	43	35	4,845	4,620	5,195	4,965
48×30	B	26	43	35	5,445	5,190	5,810	5,555
48×30	C	26	43	35	6,560	6,250	6,970	6,660
48×30	D	26	43	35	7,580	7,230	8,055	7,705
48×36	A	29	46	35	5,280	5,055	5,740	5,515
48×36	B	29	46	35	5,995	5,735	6,535	6,275
48×36	C	29	46	35	7,210	6,900	7,815	7,510
48×36	D	29	46	35	8,320	7,975	9,020	8,675
48×42	A	32	49	35	5,815	5,590	6,480	6,250
48×42	B	32	49	35	6,565	6,305	7,305	7,050
48×42	C	32	49	35	7,925	7,620	8,805	8,490
48×42	D	32	49	35	9,150	8,800	10,150	9,800
48×48	A	35	52	35	6,390	6,165	7,300	7,075
48×48	B	35	52	35	7,220	6,965	8,235	7,980
48×48	C	35	52	35	8,720	8,410	9,945	9,630
48×48	D	35	52	35	10,065	9,715	11,465	11,115

* All weights are rounded out to the nearest 5-lb multiple.

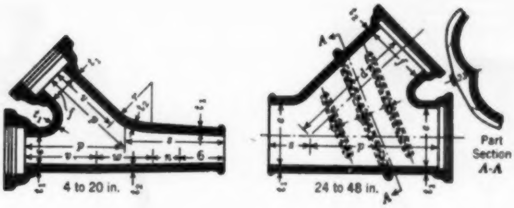
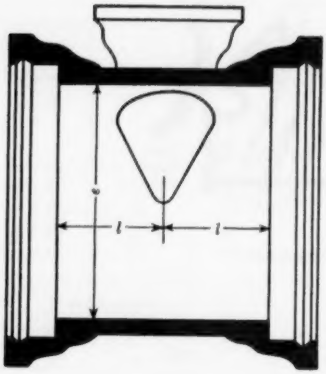


TABLE 6. Standard Y Branches

Size *in.* ($e \times f$)	Class	Dimensions—*in.*		Weight*—*lb*	
		p	*s*	2 Bells	3 Bells
4×4	D	10.50	11.50	110	125
6×4	D	13.00	13.00	160	185
6×6	D	13.00	13.00	175	200
8×4	D	16.00	14.00	235	270
8×6	D	16.00	14.00	255	285
8×8	D	16.00	14.00	275	310
10×6	D	18.50	15.50	355	390
10×8	D	18.50	15.50	380	420
10×10	D	18.50	15.50	400	445
12×6	D	21.50	15.50	470	515
12×8	D	21.50	15.50	500	545
12×10	D	21.50	15.50	525	570
12×12	D	21.50	15.50	555	605
14×6	B	24.00	16.00	525	580
14×6	D	24.00	16.00	615	670
14×8	B	24.00	16.00	555	610
14×8	D	24.00	16.00	645	700
14×10	B	24.00	16.00	590	640
14×10	D	24.00	16.00	675	730
14×12	B	24.00	16.00	620	675
14×12	D	24.00	16.00	710	765
14×14	B	24.00	16.00	625	680
14×14	D	24.00	16.00	750	800
16×8	B	31.00	17.50	820	890
16×8	D	31.00	17.50	995	1,070
16×10	B	31.00	17.50	860	935
16×10	D	31.00	17.50	1,035	1,110
16×12	B	31.00	17.50	905	980
16×12	D	31.00	17.50	1,080	1,155
16×14	B	31.00	17.50	915	990
16×14	D	31.00	17.50	1,130	1,205
16×16	B	31.00	17.50	965	1,040
16×16	D	31.00	17.50	1,205	1,285
18×10	B	34.00	18.00	1,065	1,150
18×10	D	34.00	18.00	1,310	1,400
18×12	B	34.00	18.00	1,110	1,195
18×12	D	34.00	18.00	1,355	1,445
18×14	B	34.00	18.00	1,120	1,205
18×14	D	34.00	18.00	1,415	1,500
18×16	B	34.00	18.00	1,185	1,270
18×16	D	34.00	18.00	1,495	1,585
18×18	B	34.00	18.00	1,225	1,305
18×18	D	34.00	18.00	1,565	1,655
20×12	B	37.00	18.75	1,355	1,455
20×12	D	37.00	18.75	1,650	1,770
20×14	B	37.00	18.75	1,365	1,465
20×14	D	37.00	18.75	1,715	1,830
20×16	B	37.00	18.75	1,430	1,530
20×16	D	37.00	18.75	1,805	1,920
20×18	B	37.00	18.75	1,485	1,585
20×18	D	37.00	18.75	1,880	1,995
20×20	B	37.00	18.75	1,530	1,630
20×20	D	37.00	18.75	1,935	2,055

* All weights are rounded out to nearest 5-lb multiple.



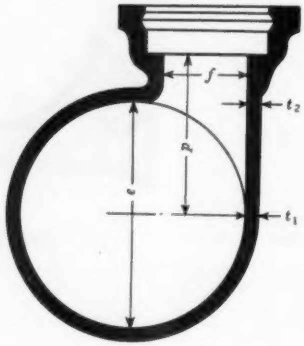


TABLE 7. Standard Blowoff Branches

Size *in.* e	Size *in.* f	Class	Dimensions *in.* l	Dimensions *in.* p	Dimensions *in.* t_1	Dimensions *in.* t_2	Weight* *lb*
8	4	D	12	7	0.60	0.52	230
10	4	D	12	8	0.68	0.52	300
10	6	D	12	8	0.68	0.55	310
12	4	D	12	10	0.75	0.52	370
12	6	D	12	10	0.75	0.55	385
14	4	B	12	11	0.66	0.52	415
14	4	D	12	11	0.82	0.52	480
14	6	B	12	11	0.66	0.55	425
14	6	D	12	11	0.82	0.55	495
16	4	B	12	12	0.70	0.52	510
16	4	D	12	12	0.89	0.52	605
16	6	B	12	12	0.70	0.55	525
16	6	D	12	12	0.89	0.55	620
18	4	B	12	13	0.75	0.52	600
18	4	D	12	13	0.96	0.52	730
18	6	B	12	13	0.75	0.55	615
18	6	D	12	13	0.96	0.55	740
20	4	B	12	14	0.80	0.52	700
20	4	D	12	14	1.03	0.52	870
20	6	B	12	14	0.80	0.55	710
20	6	D	12	14	1.03	0.55	880
24	6	B	12	16	0.89	0.55	920
24	6	D	12	16	1.16	0.55	1,165
24	8	B	12	16	0.89	0.60	935
24	8	D	12	16	1.16	0.60	1,175
30	8	A	13	20	0.88	0.60	1,345
30	8	B	13	20	1.03	0.60	1,455
30	8	C	13	20	1.20	0.60	1,690
30	8	D	13	20	1.37	0.60	1,950
30	12	A	13	20	0.88	0.75	1,385
30	12	B	13	20	1.03	0.75	1,490
30	12	C	13	20	1.20	0.75	1,725
30	12	D	13	20	1.37	0.75	1,980
36	8	A	13	23	0.99	0.60	1,750
36	8	B	13	23	1.15	0.60	2,025
36	8	C	13	23	1.36	0.60	2,345
36	8	D	13	23	1.58	0.60	2,695
36	12	A	13	23	0.99	0.75	1,800
36	12	B	13	23	1.15	0.75	2,065
36	12	C	13	23	1.36	0.75	2,375
36	12	D	13	23	1.58	0.75	2,720
42	12	A	15	26	1.10	0.75	2,555
42	12	B	15	26	1.28	0.75	2,850
42	12	C	15	26	1.54	0.75	3,395
42	12	D	15	26	1.78	0.75	3,895
42	16	A	15	26	1.10	0.70	2,575
42	16	B	15	26	1.28	0.70	2,870
42	16	C	15	26	1.54	0.89	3,460
42	16	D	15	26	1.78	0.89	3,940
48	12	A	17	30	1.26	0.75	3,435
48	12	B	17	30	1.42	0.75	3,840
48	12	C	17	30	1.71	0.75	4,610
48	12	D	17	30	1.96	0.75	5,300
48	16	A	17	30	1.26	0.70	3,440
48	16	B	17	30	1.42	0.70	3,850
48	16	C	17	30	1.71	0.89	4,660
48	16	D	17	30	1.96	0.89	5,335
54	12	A	19	33	1.35	0.75	4,505
54	12	B	19	33	1.55	0.75	5,170
54	12	C	19	33	1.90	0.75	6,245
54	12	D	19	33	2.23	0.75	7,295
54	16	A	19	33	1.35	0.70	4,515
54	16	B	19	33	1.55	0.70	5,175
54	16	C	19	33	1.90	0.89	6,300
54	16	D	19	33	2.23	0.89	7,340
60	12	A	21	36	1.39	0.75	5,540
60	12	B	21	36	1.67	0.75	6,430
60	12	C	21	36	2.00	0.75	7,740
60	12	D	21	36	2.38	0.75	9,155
60	16	A	21	36	1.39	0.70	5,555
60	16	B	21	36	1.67	0.70	6,440
60	16	C	21	36	2.00	0.89	7,795
60	16	D	21	36	2.38	0.89	9,185

* All weights are rounded out to the nearest 5-lb multiple.

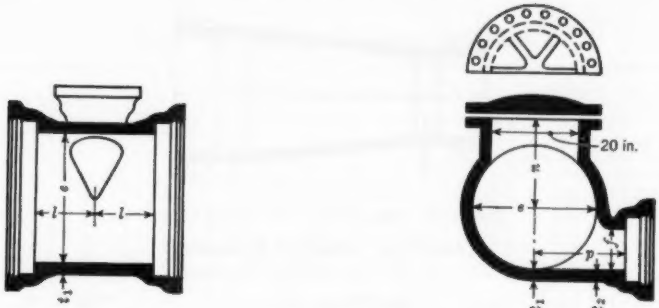


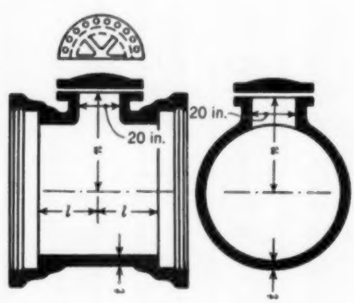
TABLE 8. Standard Blowoff Branches With Manhole

Size *in.*		Class	Dimensions *in.*					Weight* *lb*	Size *in.*		Class	Dimensions *in.*					Weight* *lb*
e	*f*		*l*	*p*	*n*	t_1	t_2		*e*	*f*		*l*	*p*	*n*	t_1	t_2	
30	8	A	21	20	26.0	0.88	0.60	2,240	48	12	A	21	30	35.0	1.26	0.75	4,330
30	8	B	21	20	26.0	1.03	0.60	2,400	48	12	B	21	30	35.0	1.42	0.75	4,790
30	8	C	21	20	26.0	1.20	0.60	2,735	48	12	C	21	30	35.0	1.71	0.75	5,655
30	8	D	21	20	26.0	1.37	0.60	3,060	48	12	D	21	30	35.0	1.96	0.75	6,415
30	12	A	21	20	26.0	0.88	0.75	2,285	48	16	A	21	30	35.0	1.26	0.70	4,345
30	12	B	21	20	26.0	1.03	0.75	2,435	48	16	B	21	30	35.0	1.42	0.70	4,795
30	12	C	21	20	26.0	1.20	0.75	2,770	48	16	C	21	30	35.0	1.71	0.89	5,710
30	12	D	21	20	26.0	1.37	0.75	3,090	48	16	D	21	30	35.0	1.96	0.89	6,455
36	8	A	21	23	29.0	0.99	0.60	2,760	54	12	A	28	33	38.5	1.35	0.75	6,155
36	8	B	21	23	29.0	1.15	0.60	3,110	54	12	B	28	33	38.5	1.55	0.75	6,975
36	8	C	21	23	29.0	1.36	0.60	3,555	54	12	C	28	33	38.5	1.90	0.75	8,370
36	8	D	21	23	29.0	1.58	0.60	4,005	54	12	D	28	33	38.5	2.23	0.75	9,695
36	12	A	21	23	29.0	0.99	0.75	2,805	54	16	A	28	33	38.5	1.35	0.70	6,160
36	12	B	21	23	29.0	1.15	0.75	3,145	54	16	B	28	33	38.5	1.55	0.70	6,985
36	12	C	21	23	29.0	1.36	0.75	3,590	54	16	C	28	33	38.5	1.90	0.89	8,425
36	12	D	21	23	29.0	1.58	0.75	4,035	54	16	D	28	33	38.5	2.23	0.89	9,735
42	12	A	21	26	32.0	1.10	0.75	3,535	60	12	A	28	36	42.0	1.39	0.75	7,065
42	12	B	21	26	32.0	1.28	0.75	3,900	60	12	B	28	36	42.0	1.67	0.75	8,145
42	12	C	21	26	32.0	1.54	0.75	4,570	60	12	C	28	36	42.0	2.00	0.75	9,715
42	12	D	21	26	32.0	1.78	0.75	5,170	60	12	D	28	36	42.0	2.38	0.75	11,400
42	16	A	21	26	32.0	1.10	0.70	3,555	60	16	A	28	36	42.0	1.39	0.70	7,065
42	16	B	21	26	32.0	1.28	0.70	3,910	60	16	B	28	36	42.0	1.67	0.70	8,145
42	16	C	21	26	32.0	1.54	0.89	4,640	60	16	C	28	36	42.0	2.00	0.89	9,770
42	16	D	21	26	32.0	1.78	0.89	5,205	60	16	D	28	36	42.0	2.38	0.89	11,445

* All weights are rounded out to the nearest 5-lb multiple. The approximate weight of the manhole cap is 290 lb. Manholes are regularly furnished with blank flange, bolts, nuts, and gasket.

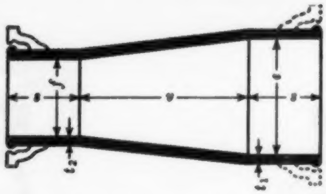
TABLE 9. Standard Manhole Pipe*

Size *in.*	Class	*n* *in.*	*l*, *in.*	Weight† *lb*	Size *in.*	Class	*n* *in.*	*l*, *in.*	Weight† *lb*
30	A	26.0	21	2,155	48	A	35.0	21	4,185
30	B	26.0	21	2,320	48	B	35.0	21	4,655
30	C	26.0	21	2,660	48	C	35.0	21	5,540
30	D	26.0	21	2,990	48	D	35.0	21	6,320
36	A	29.0	21	2,675	54	A	38.5	28	5,995
36	B	29.0	21	3,025	54	B	38.5	28	6,835
36	C	29.0	21	3,485	54	C	38.5	28	8,255
36	D	29.0	21	3,935	54	D	38.5	28	9,600
42	A	32.0	21	3,400	60	A	42.0	28	6,900
42	B	32.0	21	3,775	60	B	42.0	28	8,005
42	C	32.0	21	4,470	60	C	42.0	28	9,595
42	D	32.0	21	5,075	60	D	42.0	28	11,310



* Dimension *t* is as given in Table 8 for t_1.

† All weights are rounded out to the nearest 5-lb multiple. The weight of manhole pipe, with and without blowoff, includes the 300-lb weight of blank flange, steel nuts and bolts. Manholes are regularly furnished with 20-in. blank flange, bolts, nuts, and gasket.



Reducer (R). Size Range: 6 × 4 to 60 × 54 in.

TABLE 10. Standard Reducers

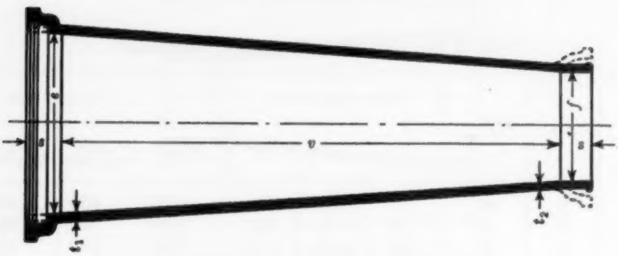
Size in. e	Size in. f	Class	Reducer Type*	Dimensions†—in. v	t_1	t_2	Weight‡—lb 2 Bells	Large End Bell	Small End Bell	Spigot Ends
6	4	D	R	18	0.55	0.52	125	105	100	80
8	4	D	R	18	0.60	0.52	155	135	120	100
8	6	D	R	18	0.60	0.55	180	155	145	120
10	4	D	R	18	0.68	0.52	185	170	145	130
10	6	D	R	18	0.68	0.55	210	190	170	145
10	8	D	R	18	0.68	0.60	245	210	205	170
12	4	D	R	18	0.75	0.52	225	205	175	155
12	6	D	R	18	0.75	0.55	250	225	200	175
12	8	D	R	18	0.75	0.60	280	245	230	200
12	10	D	R	18	0.75	0.68	315	275	270	230
14	6	B	R	20	0.66	0.55	270	250	220	195
14	6	D	R	20	0.82	0.55	305	280	250	225
14	8	B	R	20	0.66	0.60	305	270	250	220
14	8	D	R	20	0.82	0.60	340	305	285	250
14	10	B	R	20	0.66	0.68	345	305	290	250
14	10	D	R	20	0.82	0.68	380	340	325	285
14	12	B	R	20	0.66	0.75	385	335	330	280
14	12	D	R	20	0.82	0.75	420	370	365	320
16	6	B	R	20	0.70	0.55	320	295	245	220
16	6	D	R	20	0.89	0.55	365	340	290	265
16	8	B	R	20	0.70	0.60	355	320	280	250
16	8	D	R	20	0.89	0.60	400	370	325	290
16	10	B	R	20	0.70	0.68	395	350	320	280
16	10	D	R	20	0.89	0.68	440	400	365	325
16	12	B	R	20	0.70	0.75	435	385	360	310
16	12	D	R	20	0.89	0.75	485	435	405	360
16	14	B	R	20	0.70	0.66	445	390	370	320
16	14	D	R	20	0.89	0.82	535	480	460	405
18	8	B	R	20	0.75	0.60	400	365	315	280
18	8	D	R	20	0.96	0.60	460	430	370	335
18	10	B	R	20	0.75	0.68	440	395	355	310
18	10	D	R	20	0.96	0.68	500	460	410	370
18	12	B	R	20	0.75	0.75	480	430	395	345
18	12	D	R	20	0.96	0.75	545	495	450	405

* Reducer type illustrated on p. 340 indicated by "R"; long reducer shown on p. 342 by "L"; short reducer (p. 345) by "S."
† For all sizes $S = 8$ in.
‡ All weights are rounded out to the nearest 5-lb. multiple.

TABLE 10. Standard Reducers (continued)

Size *in.*		Class	Reducer Type*	Dimensions†—*in.*			Weight‡—*lb*			
e	*f*			*v*	t_1	t_2	2 Bells	Large End Bell	Small End Bell	Spigot Ends
18	14	B	R	20	0.75	0.66	490	435	405	350
18	14	D	R	20	0.96	0.82	595	540	505	450
18	16	B	R	20	0.75	0.70	540	470	455	385
18	16	D	R	20	0.96	0.89	660	585	570	495
20	10	B	R	26	0.80	0.68	545	505	445	405
20	10	D	R	26	1.03	0.68	640	600	525	485
20	12	B	R	26	0.80	0.75	595	545	495	450
20	12	D	R	26	1.03	0.75	690	645	575	525
20	14	B	R	26	0.80	0.66	605	550	505	455
20	14	D	R	26	1.03	0.82	750	695	635	580
20	16	B	R	26	0.80	0.70	660	590	565	490
20	16	D	R	26	1.03	0.89	825	750	710	630
20	18	B	R	26	0.80	0.75	715	630	615	530
20	18	D	R	26	1.03	0.96	895	805	780	690
24	14	B	R	26	0.89	0.66	720	665	595	545
24	14	D	R	26	1.16	0.82	910	855	755	700
24	16	B	R	26	0.89	0.70	780	705	655	580
24	16	D	R	26	1.16	0.89	985	910	835	755
24	18	B	R	26	0.89	0.75	830	745	710	625
24	18	D	R	26	1.16	0.96	1,060	965	905	815
24	20	B	R	26	0.89	0.80	895	795	770	670
24	20	D	R	26	1.16	1.03	1,145	1,030	990	875
30	18	A	R	26	0.88	0.75	985	900	790	710
30	18	B	R	26	1.03	0.75	1,045	960	865	780
30	18	C	R	26	1.20	0.96	1,250	1,160	1,045	950
30	18	D	R	26	1.37	0.96	1,385	1,290	1,130	1,040
30	20	A	S	26	0.88	0.80	1,045	945	855	755
30	20	B	S	26	1.03	0.80	1,105	1,010	930	830
30	20	C	S	26	1.20	1.03	1,340	1,225	1,130	1,015
30	20	D	S	26	1.37	1.03	1,475	1,355	1,220	1,105
30	20	A	L	66	0.88	0.80	1,755	1,660	1,565	1,465
30	20	B	L	66	1.03	0.80	1,885	1,790	1,710	1,610
30	20	C	L	66	1.20	1.03	2,295	2,180	2,085	1,970
30	20	D	L	66	1.37	1.03	2,510	2,395	2,255	2,140
30	24	A	S	26	0.88	0.89	1,170	1,045	975	855
30	24	B	S	26	1.03	0.89	1,230	1,110	1,055	930
30	24	C	S	26	1.20	1.16	1,510	1,360	1,300	1,150
30	24	D	S	26	1.37	1.16	1,645	1,495	1,390	1,240
30	24	A	L	66	0.88	0.89	1,975	1,850	1,785	1,660
30	24	B	L	66	1.03	0.89	2,110	1,985	1,935	1,810
30	24	C	L	66	1.20	1.16	2,595	2,445	2,390	2,235
30	24	D	L	66	1.37	1.16	2,820	2,665	2,565	2,410

* Reducer type illustrated on p. 340 indicated by "R"; long reducer shown on p. 342 by "L"; short reducer (p. 345) by "S."
† For all sizes $S = 8$ in.
‡ All weights are rounded out to the nearest 5-lb multiple.



Long Reducer (L). Size Range: 30 × 20 to 60 × 54 in.

TABLE 10. Standard Reducers (continued)

Size *in.*		Class	Reducer Type*	Dimensions†—*in.*			Weight‡—*lb*			
e	*f*			*v*	t_1	t_2	2 Bells	Large End Bell	Small End Bell	Spigot Ends
36	20*	A	S	32	0.99	0.80	1,380	1,280	1,135	1,040
36	20	B	S	32	1.15	0.80	1,530	1,430	1,245	1,145
36	20	C	S	32	1.36	1.03	1,840	1,725	1,520	1,405
36	20	D	S	32	1.58	1.03	2,035	1,920	1,670	1,555
36	20	A	L	66	0.99	0.80	2,105	2,005	1,860	1,765
36	20	B	L	66	1.15	0.80	2,325	2,230	2,045	1,945
36	20	C	L	66	1.36	1.03	2,820	2,705	2,500	2,385
36	20	D	L	66	1.58	1.03	3,120	3,005	2,755	2,640
36	24	A	S	32	0.99	0.89	1,520	1,400	1,280	1,155
36	24	B	S	32	1.15	0.89	1,675	1,550	1,390	1,265
36	24	C	S	32	1.36	1.16	2,040	1,885	1,715	1,565
36	24	D	S	32	1.58	1.16	2,235	2,085	1,875	1,720
36	24	A	L	66	0.99	0.89	2,335	2,210	2,090	1,965
36	24	B	L	66	1.15	0.89	2,560	2,435	2,275	2,155
36	24	C	L	66	1.36	1.16	3,135	2,985	2,815	2,665
36	24	D	L	66	1.58	1.16	3,440	3,290	3,080	2,930
36	30	A	S	32	0.99	0.88	1,690	1,500	1,450	1,255
36	30	B	S	32	1.15	1.03	1,930	1,755	1,645	1,470
36	30	C	S	32	1.36	1.20	2,265	2,055	1,945	1,735
36	30	D	S	32	1.58	1.37	2,630	2,375	2,265	2,010
36	30	A	L	66	0.99	0.89	2,575	2,380	2,330	2,140
36	30	B	L	66	1.15	1.03	2,960	2,785	2,680	2,500
36	30	C	L	66	1.36	1.20	3,485	3,275	3,165	2,955
36	30	D	L	66	1.58	1.37	4,040	3,790	3,680	3,425
42	20	A	S	32	1.10	0.80	1,675	1,575	1,335	1,235
42	20	B	S	32	1.28	0.80	1,825	1,725	1,470	1,375
42	20	C	S	32	1.54	1.03	2,235	2,120	1,815	1,700
42	20	D	S	32	1.78	1.03	2,485	2,370	2,005	1,890
42	20	A	L	66	1.10	0.80	2,530	2,430	2,190	2,095
42	20	B	L	66	1.28	0.80	2,775	2,675	2,420	2,325
42	20	C	L	66	1.54	1.03	3,415	3,300	2,990	2,875
42	20	D	L	66	1.78	1.03	3,785	3,670	3,305	3,190

* Reducer type illustrated on p. 340 indicated by "R"; long reducer shown on p. 342 by "L"; short reducer (p. 345) by "S."
† For all sizes, $S = 8$ in.
‡ All weights are rounded out to the nearest 5-lb multiple.

TABLE 10. Standard Reducers (continued)

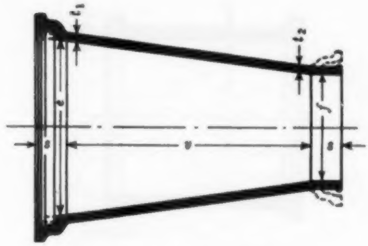
Size *in.*		Class	Reducer Type*	Dimensions†—*in.*			Weight‡—*lb*			
e	*f*			*v*	t_1	t_2	2 Bells	Large End Bell	Small End Bell	Spigot Ends
42	24	A	S	32	1.10	0.89	1,820	1,695	1,480	1,355
42	24	B	S	32	1.28	0.89	1,975	1,850	1,620	1,495
42	24	C	S	32	1.54	1.16	2,440	2,290	2,015	1,865
42	24	D	S	32	1.78	1.16	2,690	2,540	2,210	2,060
42	24	A	L	66	1.10	0.89	2,770	2,645	2,430	2,305
42	24	B	L	66	1.28	0.89	3,020	2,895	2,665	2,540
42	24	C	L	66	1.54	1.16	3,745	3,590	3,320	3,170
42	24	D	L	66	1.78	1.16	4,125	3,975	3,645	3,495
42	30	A	S	32	1.10	0.88	1,990	1,800	1,650	1,460
42	30	B	S	32	1.28	1.03	2,235	2,060	1,885	1,705
42	30	C	S	32	1.54	1.20	2,670	2,465	2,250	2,040
42	30	D	S	32	1.78	1.37	3,095	2,840	2,615	2,360
42	30	A	L	66	1.10	0.88	3,015	2,820	2,675	2,480
42	30	B	L	66	1.28	1.03	3,435	3,255	3,080	2,905
42	30	C	L	66	1.54	1.20	4,105	3,895	3,680	3,475
42	30	D	L	66	1.78	1.37	4,750	4,495	4,270	4,015
42	36	A	S	32	1.10	0.99	2,240	1,995	1,900	1,655
42	36	B	S	32	1.28	1.15	2,570	2,285	2,215	1,930
42	36	C	S	32	1.54	1.36	3,060	2,740	2,635	2,315
42	36	D	S	32	1.78	1.58	3,540	3,180	3,060	2,700
42	36	A	L	66	1.10	0.99	3,400	3,155	3,060	2,820
42	36	B	L	66	1.28	1.15	3,925	3,640	3,570	3,285
42	36	C	L	66	1.54	1.36	4,690	4,370	4,270	3,945
42	36	D	L	66	1.78	1.58	5,445	5,080	4,960	4,600
48	30	A	S	66	1.26	0.88	3,525	3,335	3,125	2,935
48	30	B	S	66	1.42	1.03	3,990	3,815	3,540	3,360
48	30	C	S	66	1.71	1.20	4,780	4,570	4,235	4,025
48	30	D	S	66	1.96	1.37	5,530	5,275	4,890	4,635
48	30	A	L	132	1.26	0.88	5,870	5,675	5,470	5,275
48	30	B	L	132	1.42	1.03	6,675	5,500	6,225	6,050
48	30	C	L	132	1.71	1.20	7,995	7,785	7,450	7,240
48	30	D	L	132	1.96	1.37	9,230	8,975	8,590	8,335
48	36	A	S	66	1.26	0.99	3,930	3,685	3,530	3,285
48	36	B	S	66	1.42	1.15	4,495	4,215	4,045	3,760
48	36	C	S	66	1.71	1.36	5,385	5,065	4,840	4,520
48	36	D	S	66	1.96	1.58	6,245	5,880	5,605	5,240
48	36	A	L	132	1.26	0.99	6,560	6,315	6,155	5,915
48	36	B	L	132	1.42	1.15	7,510	7,225	7,055	6,770
48	36	C	L	132	1.71	1.36	9,005	8,685	8,460	8,140
48	36	D	L	132	1.96	1.58	10,445	10,080	9,805	9,440

* Reducer type illustrated on p. 340 indicated by "R"; long reducer shown on p. 342 by "L"; short reducer (p. 345) by "S."
† For all sizes, S = 8 in.
‡ All weights are rounded out to the nearest 5-lb multiple.

TABLE 10. Standard Reducers (continued)

Size *in.*		Class	Reduced Type*	Dimensions†—*in.*			Weight‡—*lb*			
e	*f*			*v*	t_1	t_2	2 Bells	Large End Bell	Small End Bell	Spigot Ends
48	42	A	S	66	1.26	1.10	4,410	4,070	4,010	3,670
48	42	B	S	66	1.42	1.28	5,010	4,655	4,560	4,205
48	42	C	S	66	1.71	1.54	6,065	5,640	5,515	5,095
48	42	D	S	66	1.96	1.78	7,015	6,535	6,375	5,895
48	42	A	L	132	1.26	1.10	7,350	7,010	6,950	6,610
48	42	B	L	132	1.42	1.28	8,385	8,030	7,935	7,580
48	42	C	L	132	1.71	1.54	10,150	9,730	9,605	9,185
48	42	D	L	132	1.96	1.78	11,750	11,270	11,110	10,630
54	36	A	S	66	1.35	0.99	4,435	4,190	3,925	3,680
54	36	B	S	66	1.55	1.15	5,145	4,860	4,545	4,260
54	36	C	S	66	1.90	1.36	6,205	5,885	5,500	5,180
54	36	D	S	66	2.23	1.58	7,270	6,910	6,450	6,085
54	36	A	L	132	1.35	0.99	7,375	7,130	6,865	6,620
54	36	B	L	132	1.55	1.15	8,550	8,265	7,950	7,665
54	36	C	L	132	1.90	1.36	10,345	10,025	9,640	9,320
54	36	D	L	132	2.23	1.58	12,140	11,775	11,320	10,955
54	42	A	S	66	1.35	1.10	4,925	4,585	4,415	4,075
54	42	B	S	66	1.55	1.28	5,675	5,315	5,075	4,720
54	42	C	S	66	1.90	1.54	6,900	6,480	6,200	5,775
54	42	D	S	66	2.23	1.78	8,070	7,590	7,250	6,770
54	42	A	L	132	1.35	1.10	8,190	7,850	7,675	7,335
54	42	B	L	132	1.55	1.28	9,455	9,100	8,855	8,500
54	42	C	L	132	1.90	1.54	11,535	11,110	10,830	10,405
54	42	D	L	132	2.23	1.78	13,500	13,015	12,675	12,195
54	48	A	S	66	1.35	1.26	5,500	5,100	4,985	4,585
54	48	B	S	66	1.55	1.42	6,290	5,835	5,690	5,240
54	48	C	S	66	1.90	1.71	7,655	7,110	6,950	6,405
54	48	D	S	66	2.23	1.96	8,935	8,300	8,115	7,475
54	48	A	L	132	1.35	1.26	9,180	8,780	8,665	8,265
54	48	B	L	132	1.55	1.42	10,495	10,040	9,895	9,440
54	48	C	L	132	1.90	1.71	12,800	12,255	12,095	11,550
54	48	D	L	132	2.23	1.96	14,940	14,300	14,120	13,480
60	36	A	S	66	1.39	0.99	4,885	4,640	4,255	4,010
60	36	B	S	66	1.67	1.15	5,740	5,455	5,065	4,780
60	36	C	S	66	2.00	1.36	6,885	6,565	6,060	5,735
60	36	D	S	66	2.38	1.58	8,135	7,770	7,160	6,800
60	36	A	L	132	1.39	0.99	8,085	7,840	7,455	7,210
60	36	B	L	132	1.67	1.15	9,555	9,270	8,880	8,595
60	36	C	L	132	2.00	1.36	11,460	11,140	10,635	10,315
60	36	D	L	132	2.38	1.58	13,560	13,200	12,590	12,225
60	42	A	S	66	1.39	1.10	5,380	5,040	4,750	4,410
60	42	B	S	66	1.67	1.28	6,280	5,925	5,610	5,255

* Reducer type illustrated on p. 340 indicated by "R"; long reducer shown on p. 342 by "L"; short reducer (p. 345) by "S."
† For all sizes, $S = 8$ in.
‡ All weights are rounded out to the nearest 5-lb multiple.

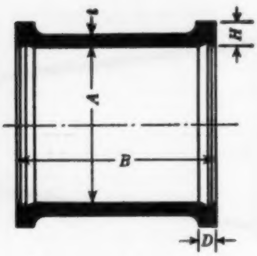


Short Reducer (S). Size Range: 30 × 20 to 60 × 54 in.

TABLE 10. Standard Reducers (continued)

Size *in.*		Class	Reducer Type*	Dimensions†—*in.*			Weight‡—*lb*			
e	*f*			*v*	t_1	t_2	2 Bells	Large End Bell	Small End Bell	Spigot Ends
60	42	C	S	66	2.00	1.54	7,600	7,175	6,770	6,350
60	42	D	S	66	2.38	1.78	8,955	8,475	7,980	7,500
60	42	A	L	132	1.39	1.10	8,915	8,575	8,285	7,945
60	42	B	L	132	1.67	1.28	10,485	10,135	9,815	9,460
60	42	C	L	132	2.00	1.54	12,680	12,260	11,855	11,435
60	42	D	L	132	2.38	1.78	14,960	14,480	13,990	13,510
60	48	A	S	66	1.39	1.26	5,965	5,565	5,335	4,935
60	48	B	S	66	1.67	1.42	6,915	6,460	6,240	5,785
60	48	C	S	66	2.00	1.71	8,365	7,820	7,540	6,995
60	48	D	S	66	2.38	1.96	9,840	9,200	8,865	8,230
60	48	A	L	132	1.39	1.26	9,925	9,525	9,295	8,895
60	48	B	L	132	1.67	1.42	11,555	11,100	10,880	10,430
60	48	C	L	132	2.00	1.71	13,975	13,430	13,150	12,605
60	48	D	L	132	2.38	1.96	16,440	15,800	15,470	14,830
60	54	A	S	66	1.39	1.35	6,515	6,005	5,885	5,370
60	54	B	S	66	1.67	1.55	7,615	7,020	6,945	6,345
60	54	C	S	66	2.00	1.90	9,265	8,560	8,435	7,730
60	54	D	S	66	2.38	2.23	10,970	10,150	10,000	9,180
60	54	A	L	132	1.39	1.35	10,825	10,315	10,195	9,685
60	54	B	L	132	1.67	1.55	12,710	12,110	12,035	11,440
60	54	C	L	132	2.00	1.90	15,475	14,770	14,645	13,940
60	54	D	L	132	2.38	2.23	18,345	17,525	17,375	16,550

* Reducer type illustrated on p. 340 indicated by "R"; long reducer shown on p. 342 by "L"; short reducer (p. 345) by "S."
† For all sizes, $S = 8$ in.
‡ All weights are rounded out to the nearest 5-lb multiple.

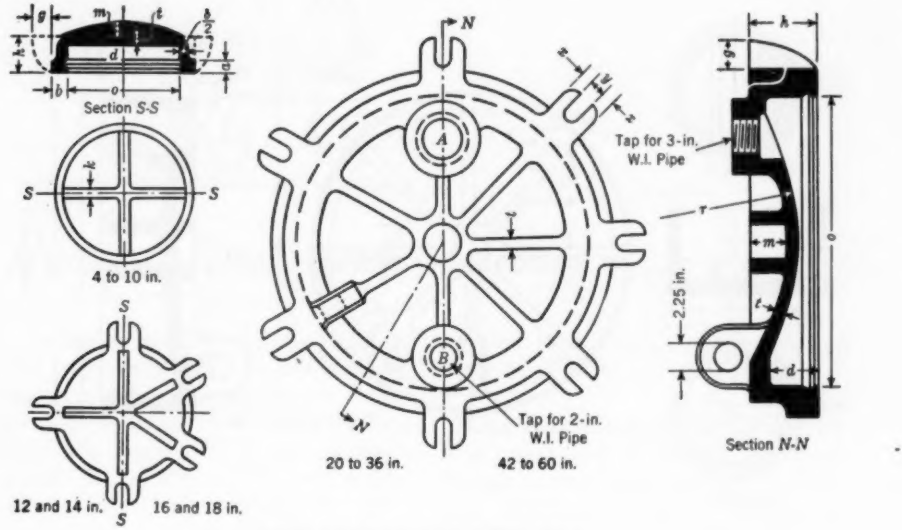


For Dimensions D and H, see Table 1.

TABLE 11. Standard Sleeves

Size *in.*	Class	Dimensions *in.* A	Dimensions *in.* B	Dimensions *in.* t	Weight* *lb*	Size *in.*	Class	Dimensions *in.* A	Dimensions *in.* B	Dimensions *in.* t	Weight* *lb*
4	D	5.80	10	0.65	45	36	B	39.40	15	1.40	920
4	D	5.80	15	0.65	65	36	C	39.80	15	1.60	1,055
6	D	7.90	10	0.70	65	36	D	40.20	15	1.80	1,195
6	D	7.90	15	0.70	90						
						36	A	39.00	24	1.25	1,175
8	D	10.10	12	0.75	100	36	B	39.40	24	1.40	1,340
8	D	10.10	15	0.75	120	36	C	39.80	24	1.60	1,540
10	D	12.20	12	0.80	130	36	D	40.20	24	1.80	1,750
10	D	12.20	18	0.80	180						
12	D	14.30	14	0.85	185	42	A	45.30	15	1.40	1,050
12	D	14.30	18	0.85	225	42	B	45.60	15	1.50	1,140
						42	C	46.20	15	1.75	1,340
14	B	16.20	15	0.85	215	42	D	46.70	15	1.95	1,530
14	B	16.20	18	0.85	255						
14	D	16.50	15	0.90	235	42	A	45.30	24	1.40	1,530
14	D	16.50	18	0.90	275	42	B	45.60	24	1.50	1,660
						42	C	46.20	24	1.75	1,960
16	B	18.50	15	0.90	270	42	D	46.70	24	1.95	2,230
16	B	18.50	24	0.90	400						
16	D	18.90	15	1.00	300	48	A	51.60	15	1.50	1,280
16	D	18.90	24	1.00	445	48	B	51.90	15	1.65	1,435
						48	C	52.50	15	1.95	1,710
18	B	20.60	15	0.95	320	48	D	53.10	15	2.20	1,950
18	B	20.60	24	0.95	470						
18	D	21.00	15	1.05	360	48	A	51.60	24	1.50	1,865
18	D	21.00	24	1.05	530	48	B	51.90	24	1.65	2,080
						48	C	52.50	24	1.95	2,490
20	B	22.70	15	1.00	370	48	D	53.10	24	2.20	2,845
20	B	22.70	24	1.00	540						
20	D	23.10	15	1.15	435	54	A	57.70	15	1.60	1,580
20	D	23.10	24	1.15	640	54	B	58.20	15	1.80	1,800
						54	C	58.90	15	2.15	2,115
24	B	26.90	15	1.05	470	54	D	59.50	15	2.45	2,410
24	B	26.90	24	1.05	685						
24	D	27.40	15	1.25	575	54	A	57.70	24	1.60	2,280
24	D	27.40	24	1.25	840	54	B	58.20	24	1.80	2,595
						54	C	58.90	24	2.15	3,080
30	A	32.80	15	1.15	625	54	D	59.50	24	2.45	3,525
30	B	33.10	15	1.15	630						
30	C	33.50	15	1.32	735	60	A	63.90	15	1.70	1,850
30	D	33.80	15	1.50	860	60	B	64.50	15	1.90	2,075
						60	C	65.30	15	2.25	2,455
30	A	32.80	24	1.15	910	60	D	65.90	15	2.60	2,850
30	B	33.10	24	1.15	920						
30	C	33.50	24	1.32	1,075	60	A	63.90	24	1.70	2,670
30	D	33.80	24	1.50	1,250	60	B	64.50	24	1.90	3,000
						60	C	65.30	24	2.25	3,570
36	A	39.00	15	1.25	810	60	D	65.90	24	2.60	4,150

* All weights are rounded out to the nearest 5-lb multiple.

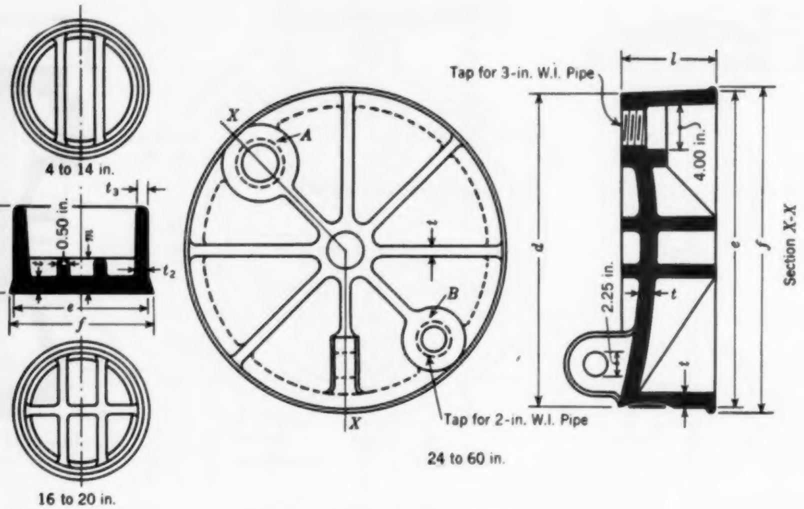


Bosses A and B cast on only when so ordered

TABLE 12. Standard Caps

Size in.	Class	Dimensions*—in.							Approx. Weight—lb	
		d	o	l	t	m	k	r	Without Lugs	With Lugs
4	D	4.00	5.70	....	0.60	....	....	.....	25	...
6	D	4.00	7.80	....	0.65	....	....	.....	40	...
8	D	4.00	10.00	....	0.75	....	....	.....	60	...
10	D	4.00	12.10	....	0.75	1.50	0.75	16.20	85	...
12	D	4.00	14.20	....	0.75	1.75	0.75	18.70	110	140
14	B	4.00	16.10	....	0.90	1.90	0.75	22.40	135	165
14	D	4.00	16.45	....	0.90	1.90	0.75	22.40	150	180
16	B	4.00	18.40	....	1.00	2.00	0.75	27.00	185	230
16	D	4.00	18.80	....	1.00	2.00	0.75	27.00	200	245
18	B	4.00	20.50	....	1.00	2.00	1.00	32.00	230	280
18	D	4.00	20.92	....	1.00	2.00	1.00	32.90	250	300
20	B	4.00	22.60	....	1.00	3.00	1.00	18.20	280	330
20	D	4.00	23.06	....	1.00	3.00	1.00	18.20	310	360
24	B	4.00	26.80	2.50	1.05	3.50	1.00	23.50	390	440
24	D	4.00	27.32	2.50	1.05	3.50	1.00	23.50	440	490
30	A	4.50	32.74	2.62	1.15	3.50	1.15	34.80	590	665
30	B	4.50	33.00	2.62	1.15	3.50	1.15	34.80	595	670
30	C	4.50	33.40	2.62	1.15	3.50	1.15	34.80	645	725
30	D	4.50	33.74	2.62	1.15	3.50	1.15	34.80	700	785
36	A	4.50	38.96	3.12	1.25	4.00	1.25	44.00	845	925
36	B	4.50	39.30	3.12	1.30	3.95	1.25	44.00	915	995
36	C	4.50	39.70	3.12	1.35	3.90	1.25	44.00	1,000	1,085
36	D	4.50	40.16	3.12	1.40	3.85	1.25	44.00	1,085	1,170
42	A	5.00	45.20	3.37	1.40	4.00	1.40	63.50	1,275	1,395
42	B	5.00	45.50	3.37	1.50	3.90	1.40	63.50	1,395	1,520
42	C	5.00	46.10	3.37	1.60	3.80	1.40	63.50	1,545	1,675
42	D	5.00	46.58	3.37	1.70	3.70	1.40	63.50	1,685	1,820
48	A	5.00	51.50	3.62	1.70	4.00	1.50	76.50	1,700	1,915
48	B	5.00	51.80	3.62	1.90	3.80	1.50	76.50	1,945	2,075
48	C	5.00	52.40	3.62	2.00	3.70	1.50	76.50	2,140	2,275
48	D	5.00	52.98	3.62	2.10	3.60	1.50	76.50	2,335	2,475
54	A	5.50	57.66	3.87	1.90	4.50	1.50	82.00	2,375	2,515
54	B	5.50	58.10	3.87	2.00	4.40	1.50	82.00	2,555	2,700
54	C	5.50	58.80	3.87	2.10	4.30	1.50	82.00	2,800	2,950
54	D	5.50	59.40	3.87	2.20	4.20	1.50	82.00	3,045	3,195
60	A	5.50	63.80	4.12	2.00	4.50	1.50	99.00	2,900	3,045
60	B	5.50	64.40	4.12	2.10	4.40	1.50	99.00	3,105	3,250
60	C	5.50	65.20	4.12	2.20	4.30	1.50	99.00	3,395	3,545
60	D	5.50	65.82	4.12	2.30	4.20	1.50	99.00	3,680	3,835

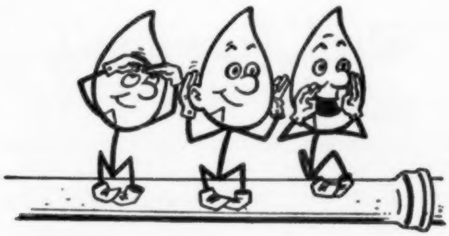
* Dimension h equals $d + t$.



Bosses A and B cast on only when so ordered

TABLE 13. Standard Plugs

Size in.	Class	Dimensions—in.								Number of Ribs	Approx. Weight lb
		e	f	d	l	m	t	t_2	t_3		
4	D	4.90	5.28	.....	5.50	....	0.50	0.40	0.20	..	8
6	D	7.00	7.38	.....	5.50	....	0.60	0.40	0.20	..	14
8	D	9.15	9.65	.....	5.50	2.00	0.60	0.40	0.20	2	25
10	D	11.20	11.70	.....	6.00	2.00	0.70	0.50	0.20	2	40
12	D	13.30	13.80	.....	6.00	2.00	0.75	0.50	0.20	2	50
14	B	15.30	15.80	.....	6.00	2.00	0.70	0.50	0.20	2	60
14	D	15.65	16.15	.....	6.00	2.00	0.75	0.50	0.20	2	65
16	B	17.40	17.90	.....	6.50	2.00	0.70	0.50	0.30	3	90
16	D	17.80	18.30	.....	6.50	2.00	0.80	0.60	0.30	3	95
18	B	19.50	20.00	.....	6.50	2.50	0.75	0.60	0.30	3	110
18	D	19.92	20.42	.....	6.50	2.50	0.85	0.60	0.30	3	120
20	B	21.60	22.10	.....	6.50	2.75	0.85	0.60	0.30	3	150
20	D	22.06	22.56	.....	6.50	2.75	1.00	0.60	0.30	3	155
24	B	25.92	26.30	25.68	8.00	....	0.89	....	....	4	375
24	D	26.44	26.82	26.20	8.00	....	1.16	....	....	4	470
30	A	31.86	32.24	31.62	8.00	....	0.88	....	....	4	480
30	B	32.12	32.50	31.88	8.00	....	1.03	....	....	4	555
30	C	32.52	32.90	32.28	8.00	....	1.20	....	....	4	640
30	D	32.86	33.24	32.62	8.00	....	1.37	....	....	4	725
36	A	38.08	38.46	37.84	8.00	....	0.99	....	....	4	680
36	B	38.42	38.80	38.18	8.00	....	1.15	....	....	4	785
36	C	38.82	39.20	38.58	8.00	....	1.36	....	....	4	915
36	D	39.28	39.66	39.04	8.00	....	1.58	....	....	4	1,050
42	A	44.32	44.70	44.08	9.00	....	1.10	....	....	4	990
42	B	44.62	45.00	44.38	9.00	....	1.28	....	....	4	1,140
42	C	45.22	45.60	44.98	9.00	....	1.54	....	....	4	1,355
42	D	45.70	46.08	45.46	9.00	....	1.78	....	....	4	1,550
48	A	50.62	51.00	50.38	9.00	....	1.26	....	....	4	1,340
48	B	50.92	51.30	50.68	9.00	....	1.42	....	....	4	1,505
48	C	51.52	51.90	51.28	9.00	....	1.71	....	....	4	1,800
48	D	52.10	52.48	51.86	9.00	....	1.96	....	....	4	2,045
54	A	56.78	57.16	56.54	9.00	....	1.35	....	....	4	1,695
54	B	57.22	57.60	56.98	9.00	....	1.55	....	....	4	1,945
54	C	57.92	58.30	57.68	9.00	....	1.90	....	....	4	2,355
54	D	58.52	58.90	58.28	9.00	....	2.23	....	....	4	2,735
60	A	62.92	63.30	62.68	9.00	....	1.39	....	....	4	2,045
60	B	63.52	63.90	63.28	9.00	....	1.67	....	....	4	2,435
60	C	64.32	64.70	64.08	9.00	....	2.00	....	....	4	2,905
60	D	64.94	65.32	64.70	9.00	....	2.38	....	....	4	3.395



Percolation and Runoff

In the Army now, together with its new crop of civilians, is a new batch of almost civilianized water supply equipment to keep the boys from missing home too much. That isn't, perhaps, exactly descriptive of the new iodine pill which recently replaced the chlorine pellet as a purifier of personal drinking water, but the fact that the iodine does eliminate the bad taste as well as the danger is a big step homeward. Not exactly household, either, is the new ice and snow converter, which not only liquefies winter by live steam, but can burn holes through the ice of fresh-water lakes to get at the supply beneath. Nor can the recently developed plastic life-raft bubble, which uses the sun's rays to distill sea water into a 5-pint-per-day drinking supply, be called a backyard swimming pool item. But what is definitely homey is the foxhole showerbath—a mobile unit that has been carrying real hot-water showers to the front lines. Mounted on a two-wheel trailer, the unit is towed around by a jeep to a convenient river or pond from which it can draw water into its boiler. There the water is heated scalding hot to kill off bacteria before it is led off, through cooling tubes surrounded by the incoming water, to the 24 shower heads it serves. And with all these gadgets, not only the best watered, and therefore healthiest, but by far the sweetest smelling army of all time.

One type of water which the Army hasn't been able to provide for itself, though, is that which constitutes 92 per cent of blood plasma. It requires an average of 15 pints of whole blood to provide the plasma needed to treat one seriously wounded soldier, and the 7.6 pints of water thereby involved require even more specialized treatment than is given in the home front water plants. But every water works man between the age of 18 and 59 in normally good health has a plant of his own that ought to be able to turn out at least a pint at the nearest Red Cross intake. You don't have to give your right arm—just bare it!

Harry S. Jordan, formerly sanitary engineer with the Arizona State Dept. of Health and secretary of AWWA's Arizona Section, has been appointed industrial hygiene engineer for an operation being conducted by the Univ. of California at Los Alamos, N.M. Another vacancy in the Dept. of Health was occasioned by the resignation of Charles Trygg, senior sanitary engineer, who has joined the Carlsbad, Calif., Water Co. in the capacity of manager.

(*Continued on page 34 P&R*)

(Continued from page 33 P&R)

Six veteran officials of Neptune Meter Co.—all of them well known and respected in the water supply industry—have been retired after periods of service varying from 34 to 55 years. The six, whose simultaneous retirement is the result of a new company retirement system, have all expressed a wish to remain active in some aspect of water works activity. They are: Charles B. Bachmann, Rollo K. Blanchard, and J. Rex Van Gorder of New York; James Ryerson Barker of San Francisco; Francis Cunningham of Chicago; and Edward W. Thompson of Portland. Four of these six have earned Fuller Awards or other citations from their AWWA sections, and it is worth noting that at least five other Neptune men have received Fuller Awards: Harry W. Badley (Kansas, 1948), John R. Barnes (Iowa, 1952), Adolph D. Mars Jr. (Rocky Mountain, 1952), Michael Siebert (Virginia, 1952), and the late Egmont Smith (Southwest, 1943). Returning to the retiring six, even a glance at the record is impressive:

Bachmann joined the Neptune organization in 1901. He began by working in the tool room, joined the Engineering Dept., and in 1942 was appointed director of industrial relations.

Barker became a clerk for Neptune in 1898 and six years later took charge of its new San Francisco office. He was made a vice-president in 1939. In 1949 the California Section of AWWA accorded him its Fuller Award in recognition of his services on the section's Executive Committee and its Manufacturers Exhibits Committee.

Blanchard came to Neptune in 1910; the list of his posts includes those of chief engineering assistant to the president and secretary of the company. In 1924 he became a vice-president and director, and he will continue to hold the latter post in his retirement. He also plans to remain active as secretary-treasurer of AWWA's New York Section and as secretary of the Fuller Award Society. At their meeting in New York last January, the AWWA Board of Directors signed and presented him with a special commemorative scroll, lauding him as "a tireless worker for water works men."

Cunningham, who last year was honored by receiving a special citation from the Wisconsin Section of AWWA, has been representing Neptune in Wisconsin, Illinois, and Upper Michigan. His service dates back to 1904, when he became a service man for the Chicago office.

Thompson has been Northwest district manager since 1912, having begun in 1907 as a stenographer in the Los Angeles office. In 1951 he received the Powell-Lindsay Citation of AWWA's Pacific Northwest Section.

Van Gorder, who joined the Neptune organization in 1919, was general sales manager, director, and vice-president.

(Continued on page 36 P&R)

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Morris S. Jones, who retired from service as chief engineer and general manager of the Pasadena, Calif., Water Dept. last October 31, received a heart-warming tribute when *The Pasadenan,* the official publication of the Pasadena Municipal Employees Association, published some recollections by H. F. Jerauld, superintendent of stores and equipment for the department. "His isn't just a name that stands out because once in his younger days he might have designed an unorthodox pipe manifold," observed Jerauld. "As you visit various parts of the country and someone asks, 'Do you know Morrie Jones?' and you say, 'Yes,' the answer is always, "He sure is a swell fellow.' There is affection in their voices, and sincerity, and respect."

J. Arthur Carr, superintendent of the Ridgewood, N.J., Water Dept., died on Jan. 31 after a two-month illness. He was 63, and had served the department since 1914, when he was superintendent of the Bergen Aqueduct Co. In 1941 the New Jersey Section nominated him to receive its Fuller Award.

George W. Biggs Jr., who retired as chief engineer of the then American Water Works and Electric Co. in 1947, died on Jan. 24 at his home in New York. He was 74 years old.

Mark B. Whitaker, assistant general manager and Water Div. superintendent for the Knoxville, Tenn., Utilities Board, has been appointed acting general manager.

(Continued on page 38 P&R)

(*Continued from page 36 P&R*)

A main break was a break for some 12,000 employees of 300 tenant firms in New York City's 40-story Equitable building last month. As usual, water, itself, kept its activities well under cover, reaching no higher than the sub-sub-basement, but that was high enough to stop the building's 62 elevators and to leave the lobby mobby. Some of the top executives climbed as high as the 34th floor to reach their desks, others did business in the lobby or set up temporary headquarters, but most of those whom water left low and dry had long since forgotten how to use stairs and let water take its course.

The Montee LaDue-Rattler Larue wrestling duo that teamed up to take on a couple of local favorites at the Akron, Ohio, armory last month may not have featured W. R. LaDue, Supt. & Chief Engr., and L. Larue, Sewerage Engr., both of the Akron Bureau of Water & Sewerage, but how coincidental can you get? After all, the name Montee and a small mustache are a pretty thin disguise and who doesn't know that, in Japanese, "L" would be pronounced R, as in "Rattler"? Add to that a news item describing them as "two of the roughest performers in the business," and we're ready to take bets. "Larue, particularly," the newspaper says, "has had to be restrained on several previous appearances here. With the tough LaDue to help him, there should be no limit to tomorrow's wildness." Certainly no pair that frightening could be in professional wrestling today, so what else?

William E. Clow Jr. has been elected chairman of the board of James B. Clow & Sons, and thus fills the office left vacant since the death of his father in 1942. He has been with the firm since 1907, became a director in 1910, and from 1935 to 1941 served as president. Simultaneously John Madden was elected president of the firm to succeed the late Kent S. Clow, brother of William E. Clow Jr., and G. R. Kinnally was appointed general manager of the Jobbing Div., to take over the duties vacated by the new president.

Among those receiving 40-year awards in recognition of service to Builders Iron Foundry recently was Zechariah Chafee Jr., chairman of the board. Three other 40-year awards were presented at the company's annual Service Award Dinner, and service pins were presented to over 200 employees who had completed from 5 to 25 years of service.

(*Continued on page 40 P&R*)

(*Continued from page 38 P&R*)

Bronze water service line fittings in ½- to 2-in. size, and corporation tapping machines formerly manufactured by A. P. Smith Mfg. Co. of East Orange, N.J., are now being produced by the Kitson Valve Div. of Welsbach Corp. of Philadelphia, Pa. The transfer of designs, patterns, and production equipment between the two firms was arranged as a result of the desire of the Smith organization to concentrate its activities—and its copper allocation—on its line of valves, hydrants, and special valve inserting and drilling equipment.

Major C. Hagar, formerly city manager for Sterling, Kan., has become a representative of several manufacturing firms in the water and sewage works field. He is maintaining headquarters at Sterling, P.O. Box 465, on behalf of the following firms: Builders Iron Foundry and divisions, A. J. Griner Co., Keasbey & Mattison Co., A. Y. McDonald Mfg. Co., Palmer Filter Equipment Co., A. P. Smith Mfg. Co., Trojan Mfg. Co., and Yardley Plastics Co.

M. J. Harper has been made vice president of Rockwell Mfg. Co. In his 30 years with the Valve & Meter Div. of the organization, he had worked himself up from salesman to regional manager of the Eastern Region before his latest promotion. His headquarters will be in New York. H. Gottwald succeeds Harper as eastern regional manager and New York district manager.

James C. Judge has been appointed manager of the Portland, Ore., branch of Neptune Meter Co., succeeding E. W. Thompson, retired (see *p. 34 P&R*).

(*Continued on page 42 P&R*)

(*Continued from page 40 P&R*)

The ugly head of respectability, which we glimpsed astearing in the field of advanced rhabdomancy last January (P&R p. 34), has been making faces at us ever since. Disregarding completely such stock stickings out of the tongue as the editorial page discussion of water and oil doodlebuggery which appeared recently in the Toronto, Ont., *Globe and Mail,* and the dispatch from Castletown, Eire, about the Irish diviner who added depth determination to his repertoire under the tutelage of an even diviner monk, we still have had to face three rather harrowing upsadowsies in less than a month:

● First of these was the still unfinished story of the search for a new well site at San Clemente, Calif. There, science is getting the acid test, with mysticism lurking just behind the litmus paper. For development of a new well, geologists were given the opportunity to indicate the three most likely locations, but, recalling the reported triumph of dowsing in locating San Clemente's last well in 1929 and anxious to leave no possibilities unexplored, Water Commissioner O. W. Carrick opened a dowsing competition, with plenty of prizes. All in all 38 assorted diviners, most prepossessing of whom was V. L. Cameron, geologist, hydrologist, and engineer extraordinary of the Border Line Research Assn. [honest!], appeared and provided Commissioner Carrick with 38 additional locations, none of which remotely approached those of the geologists, but most of which fell into three reasonably well-defined areas. Plans were to give the geologists first crack with a test hole at one of the scientific locations, and then to fall back on diviner ground. Were we as foresighted as the rhabdomanticists, we'd make public our alibi now just in case what should doesn't happen—but we'll never learn!

● Second shock came from the words of a physician who has been dead for thirteen years—though the coming was not quite as mystical as that may suggest. Shocker was one G. A. M. Lintott, M.D., M.R.C.P., whose 1933 article, "Some Observations on So-called Water-Divining," was reprinted by demand in the Christmas number of *Guy's Hospital Gazette* of London and forwarded to us in undoubted triumph by a defender of the faith. The good doctor, it appears, had brought his physiology directly to bear on the problem, setting up a scientific platform with a pipe beneath and controls whereby he could regulate the flow of water through the pipe. Likewise, he kept his skeptical mind open by avoiding any reference to previous experiments—which probably explains why his twigs twitched upward and why the rods now found so effective for pipe location were then successful only on running water. But Dr. Lintott's own summary best tells his story:

> In our observations it was found that, whereas no person tested could detect the presence of still water, yet there were people who possessed sensitivity to moving water to a varying degree. . . .
>
> The twig and rods simply act as indicators and also as the means whereby the correct state of muscular tension is achieved. This explains why different observers use different thicknesses or strengths of twigs, it simply being the outward expression of a subconscious desire to get the muscular tension to the optimum state in each individual case.
>
> Three factors are thought to be concerned in the production of the response: a stimulus, the nature of which is unknown and which emanates from running water; a receptive organ in the body, the

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(*Continued from page 42 P&R*)

sensitivity of which seems to be intimately connected with muscle tone; and, lastly, the motor force which results in movement of the indicator used, and this, it appears, is a change of tone in the muscles of the hands and forearms.

It is felt that the reception of the stimulus and the production of the response is a subconscious affair concerned with the more primitive centers rather than the cerebral cortex.

It is considered that there is sufficient evidence to justify the statement that water-divining is a genuine phenomenon, and further investigation is required for the elucidation of the exact method of its production.

Unfortunately, Dr. Lintott's elucidation was precluded by his untimely demise, but there is hope that the physiological phase of rhabdomantic research will be carried on by some of his successors. Meanwhile, of course, we may well expect someone who has more basic interest in running water than that in water on the knee will also take up the Lintott thesis, particularly as it applies to those "L-shaped metal rods, the shorter limbs [of which] are loosely held, one in each hand, in a position midway between pronation and supination."

• Final spinal tingler of the month was the announcement on the 45th annual meeting program of the Indiana Section of the appearance of the four witches of Purdue University to do some "Water Witching by Air Photo Interpretation." Just what Don Bloodgood and his three broom-busting pals have in mind isn't at all clear at this moment, and, with dowse-delousers closing in at every hand, we're warier than we ought to be of anything that might be labeled aerodowsnamics.

The really happy feature of all these possibilities is that their results remain not only to be seen but to be reported, which makes mandatory some further mileage on a subject fitfully forsworn.

Wentworth Smith has been elected a director and vice-president in charge of sales of Neptune Meter Co., succeeding to the post vacated by J. Rex Van Gorder (see this issue, p. *34 P&R*). Smith joined Neptune in 1949 and became general sales manager in 1951.

Willard F. Rockwell has been drafted into the Eisenhower administration as a consultant on productivity, and will be assigned duties with the Mutual Security Agency. Col. Rockwell is chairman of the board of Rockwell Mfg. Co., Standard Steel Spring Co., and Timken-Detroit Axle Co.

(*Continued on page 46 P&R*)

Installation: Collierville, Tenn. 40,000 feet, 6-inch, Class 150 "Century" asbestos-cement pressure pipe. Construction Engineers: Allen & Hoshall. Contractor: R. L. Bernado & Son. Both firms of Memphis, Tenn.

FOR the project pictured here, the authorities of Collierville, Tennessee, selected "Century" pipe because of the same good reasons that have decided so many other communities.

The pattern of decision often goes like this: the authorities concerned investigate suitable kinds of pipe. They quickly note that "Century" asbestos-cement pressure pipe is economical to buy. And, because it is light in weight and easy to handle, its installation is quick and low in cost.

With an eye to the future, they approvingly note that "Century" pipe never tuberculates, has high resistance to soil corrosion, and actually grows stronger as the years go by!

You can see why these low-cost, long-life features appeal to thrifty citizens! There are other important features, of course, and before *you* select pipe for water mains, it will pay you to thoroughly investigate "Century" asbestos-cement pressure pipe.

Nature made Asbestos . . .
Keasbey & Mattison has made it serve mankind since 1873

FREE BOOKLET, "Mains Without Maintenance," is yours for the asking. Contains data of value to anyone concerned with pipe for water mains. Write for your copy today.

K&M best in asbestos

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

(*Continued from page 44 P&R*)

Out-of-print publications of the Geological Survey and other government agencies are the specialty of bookdealer James C. Howgate, 128 S. Church St., Schenectady 1, N.Y. He offers a list of water supply papers available, and solicits want lists.

John R. Cella of the Crane Co. has been appointed manager of the newly created Purchased Industrial Sales Section of the firm. He has been with the Chicago organization since 1937.

The roll-your-own boys have now turned to water supply as a new outlet for talents no longer appreciated in the tobacco business. And they seem to have hit pay dirt with a demineralize-your-own unit that will make tap water into a "distilled" water suitable not only for use in steam irons, storage batteries, and photographic work, but for such technical tasks as the study of blood chemistry, hydrogen ion studies, ion-free washing of laboratory apparatus, and other uses requiring chemically pure water.

Actually, the unit ought to be called a squeeze-your-own, for that is how the tap water in the polyethylene bottle is forced through the ion-exchanger in the bottle neck and out, demineralized to the point of carrying only 1 to 10 ppm impurities. Units are available in 6- to 16-oz sizes at a cost from $1.75 to $3.00, the smallest unit able to produce 20 gal of cp water before the filter needs replacement. Best known to date is the "Deeminac" of Eberbach & Son, Ann Arbor, Mich., the prices of which are noted here, but other units are also making their bow.

(*Continued on page 94 P&R*)

Correspondence

Immemorative & Commemorative

To the Editor:

Catching up with last October's P&R, I noted your prediction (P&R p. 1) of a political milennium for water as of January 31. What's wrong with January 20?

Also, noting your call to all philatelists, philatephiles, and philaterers (P&R p. 12), count me in.

GEORGE E. SYMONS
Larchmont, N.Y., Jan. 6, 1953

Much as we'd like to point out that we were merely trying to give the General a little time to become specific, we'll have to admit that Doc caught us with our civics down. On the matter of a commemorative stamp for AWWA's 75th Jubilee in 1956, however, we have a better answer: At its January meeting the Board of Directors approved the idea of coaxing a commemorative and assigned the task to fanatical philatelist Filby (hereinafter Philby) and his Committee A2.A on Public Relations, to whom more power.—ED.

Perturbation and Runon

The appearance of E. L. Bean's criticism of P&R in the January issue (P&R p. 54) has evoked considerable comment by other readers. To introduce the following excerpts from letters received, it should be pointed out that the main subject of the criticism was not the Percolation and Runoff section as a whole, but the not entirely serious items that make up an average of four pages per issue.—ED.

With today's high costs, it seems a pity to waste glossy coated stock and the printer's wages on the ephemeral material which appears in P&R.

An increase in the number of pages allocated to original contributions or to discussions of contributions; to abstracts; or to book reviews, to fill the space now squandered on P&R, would improve the tone and increase the usefulness of the JOURNAL. A second possibility would be an increase in advertising, which would yield additional income; much of the advertising has an informative value which exceeds that of P&R. A third possibility would be to cut down on the total number of pages per issue and thus cut costs. Any of these changes, or a compromise between them, would seem to me to be a worthwhile change.

I believe that many subscribers who bind their Journals order the bindery to clip off the "junk" at both ends of the JOURNAL, including P&R.

If you feel that the type of material which has been appearing in P&R has value as "the human side of the news," why not reproduce it elsewhere and by some cheaper means such as mimeograph, and distribute it as part of, or in the same mailings as, *Willing Water?*

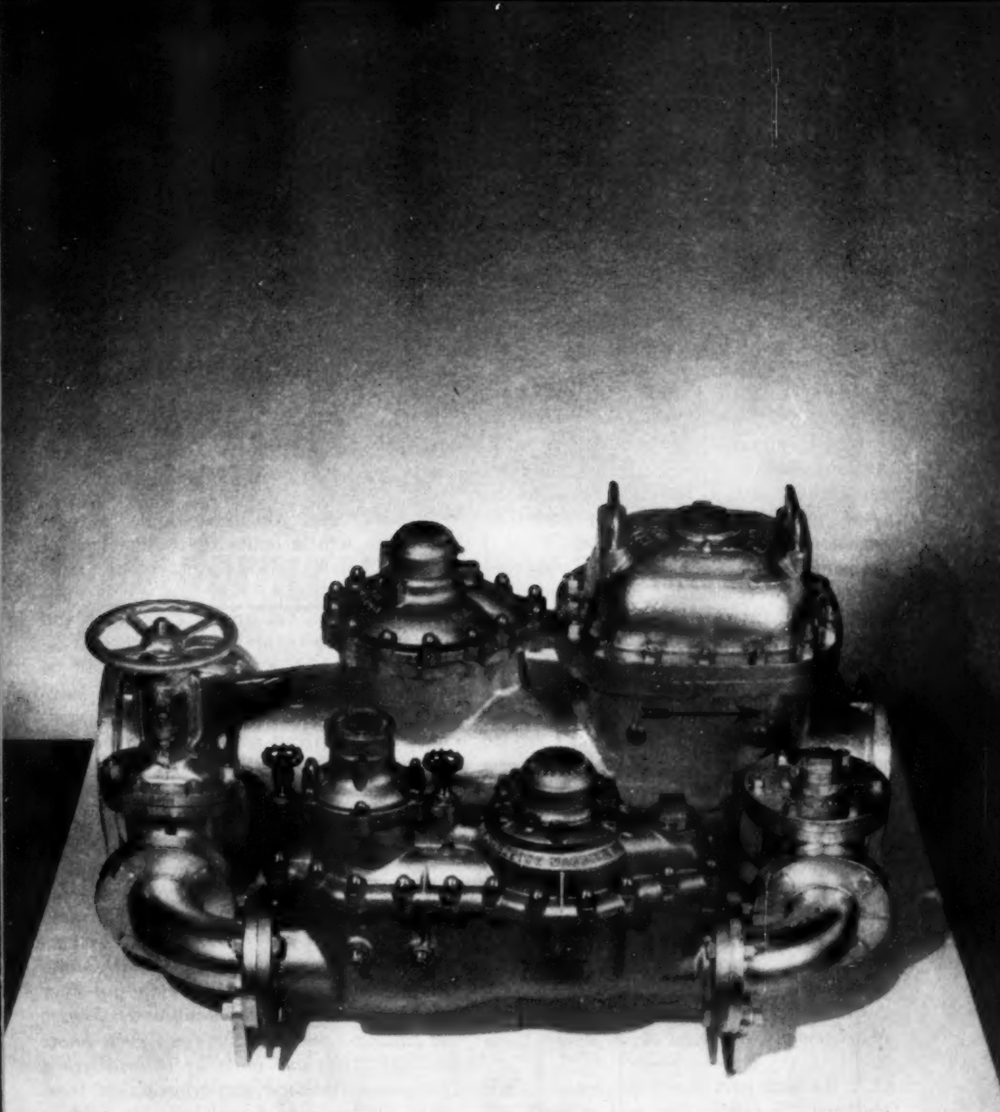
EUGENE M. DISKANT
Chemist, Dept. of Water & Power
Los Angeles, Calif.; Feb. 5, 1953

It is easy to sum up my attitude toward P&R—it is the *first* part of the JOURNAL I read.

W. VICTOR WEIR
Pres., St. Louis County Water Co.
St. Louis, Mo.; Feb. 3, 1953

The water works business, like most pursuits, has enough unpleasantness in it,

(*Continued on page 50 P&R*)



Correspondence

(*Continued from page 48 P&R*)

so that it is always a nice diversion to read material like that which has been published over the last several years in P&R.

H. E. HUDSON JR.
Head, Engineering Sub-Div.
State Water Survey Div.
Urbana, Ill.; Feb. 3, 1953

I have had copies of the AWWA JOURNAL for the last 11 years. . . . Until P&R came along I paid little attention to the issues, paging through them and only occasionally reading an article. Then I happened onto P&R writings sometime after they were begun. Right from then I've looked forward eagerly to every issue and always open first to that section, never laying the issue down until all is read, on the first day of its arrival.

The flavor of the magazine seems to be changed by this new column and I regard it all very highly. I look over the rest of the magazine much more carefully now than ever before. "The Reading Meter" and "Condensation" are also very useful and informative.

Everyone to his own taste but my taste is definitely for P&R.

ROBERT E. HANSEN
Supt., Filtration & Pumping
Mt. Clemens Water Purification Plant & Pumping Station
Mt. Clemens, Mich.; Feb. 5, 1953

. . . the best part of the JOURNAL. P&R enlivens the publication and is much enjoyed by all our staff.

S. R. MCBRIEN
Supt., Public Utilities Commission
Aglmer, Ont.; Feb. 12, 1953

. . . here's one reader who enjoys (but not always understands) P&R, and reads it even if time doesn't permit full digestion of the rest of the issue.

LLOYD K. CLARK
Clark & Groff Engrs.
Salem, Ore.; Feb. 9, 1953

The mail ballot to date has totaled 8 to 2 in favor of levity, three balloteers having asked to be counted but not quoted. Meanwhile, some of Mr. Diskant's comments are answered in the "Report on Publications" (see p. 309 this issue) and we are enough agreed on the expendability of "junk" to segregate it and number it separately for convenience in binding the text.—ED.

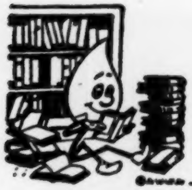
Dear Departed

To the Editor:

I notice that you have adopted a form of letter which omits the salutation. I tried, for a period of about a year, omitting both the salutation and the complimentary close, but finally gave it up and went back to both, in deference to custom. I would like to see someone put on a real campaign to get at least the salutation eliminated in business correspondence. How about some discussion in the JOURNAL on the subject?

FRANK E. ALDERMAN
Cons. Engr.
South Pasadena, Calif.; Feb. 3, 1953

When someone suggested a Society for the Elimination of the Dear in Business Letters five or six years ago, we became charter members of the organization and have remained in perfect standing ever since. Not only our unnatural shyness at calling some guy we don't even know a "dear," but our inability to establish a foolproof standard for progression from Mr. Alderman to Frank, quickly sold us on the SEDBL. Like Mr. Ald . . . Fra . . . the writer of the above letter, we also considered the elimination of the "complimentary" close, but stuck with it for its value in letting people know how we feel. Mostly, it has been "cordially" that we closed, occasionally it may have been uncomplimentarily, but never has it been "yours." As self-appointed membership committee of SEDBL (which secretly signifies "said businesslike"), we are now declaring the season open. And since the society aims to get rid of the "dear," no dough is required with your application.—ED.



The Reading Meter

The Algae of Illinois. *Lewis Hanford Tiffany & Max Edwin Britton. Univ. of Chicago Press, Chicago (1952) $10.00*

Intended as a research reference to common fresh-water algae of temperate climates, this book bridges the gap between comprehensive texts, which treat only general and higher taxonomic categories, and the definitive study of species normally found only in research monographs. Although specific to Illinois, the algae described are representative of inland water areas of North America and even the world. Extensive illustrations and information on structure, reproduction, pigmentation, and food synthesis are provided. Green algae (Chlorophyta); yellow-green and golden-brown algae and diatoms (Chrysophyta); dinophyceae (Pyrrophyta); euglenoids (Euglenophyceae); blue-green algae (Myxophyta); and red algae (Rhodophyceae) are fully described.

It is the reviewer's opinion that much more extensive study of the algae will be of great assistance to the operation of water supplies drawn from reservoirs, lakes, and rivers. One handicap to such study has been the lack of a convenient reference book for the identification of these organisms. This lack is admirably filled by Tiffany and Britton's publication.—*A. M. Buswell.*

Foundation Engineering. *Ralph B. Peck, Walter E. Hanson, & Thomas H. Thornburn. John Wiley & Sons, Inc., New York (1953) 410 pp.; $6.75*

In addition to offering basic material in soil mechanics and descriptions of foundation practice, this book offers a guide to the selection of foundation types on the basis of soil analyses, and a section on the structural design of foundation elements. A chapter on damage that can be and has been caused by construction operations takes the discussion out of the classroom with a vengeance. An unusual feature of the book are the between-the-chapters portraits and historical sketches of leading contributors to one of our newest sciences, foundation engineering.

In the Name of Science. *Martin Gardner. G. P. Putnam's Sons, New York (1952) 320 pp.; $4*

This is a book which deserves a careful reading by everyone who is forming opinions about unorthodox methods of locating ground water or buried pipelines, or of conditioning feedwater, or even of what causes or cures mental or physical ills. The fact that a method or an explanation appears to work is by too many of us considered evidence that it is "true," and a few chance successes can produce the emotional conviction that will find ready extenuation of later failures.

Ultimately the answer to any question of material "truth" requires a philosophical approach, and particularly an understanding of logic and scientific method. The fruitful method of science involves an understanding of the laws of chance and the workings of happenstance, an appreciation for the possible causes of interference, a suspension of belief equally with disbelief, and a rigid discipline to unyielding fact.

Such an approach will demolish most of the irrationalists who afflict not only water works men but the world in gen-

(*Continued on page 54 P&R*)

The Reading Meter

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eral. But it will also introduce a saving note of caution—one which, unfortunately, the author of this book mentions but fails sufficiently to observe. And that caution is the necessity for humility in judging ideas that appear novel or weird.

The water supply engineer will not be interested either in the follies or the fruitful work of such psychologists as Moreno, Szondi, and others, but he can surely appreciate that a study of scientific frauds is weakened when it is diverted, even momentarily, to the smear-by-association of the author's pet peeves.

What we who pass judgment must remember is that nearly every idea now accepted was once the daring hypothesis of a crank, who, too often, was oversold on the scope or implications of his brainchild. Unfortunately, there is no scientific method for constructing a theory. That act is and must remain one of human creation—a wild surmise, subject to all the infirmities of error, and hope, and delusion. Every good theory will include its practice, but hosts of invalid hypotheses have been advanced to explain evident facts, and it is no service to science to discard the concept of fire because the phlogiston theory is false.

It is no wonder that Kenneth Roberts remains convinced that dowsing works when he is ridiculed as technically illiterate and otherwise treated as he must think Galileo and Pasteur were treated (assuming he has any respect for those gentlemen). It is doubtless proper, and perhaps necessary, to point out that Roberts is strangely ignorant of what even an hour's patient reading of what is unequivocally ***known*** could tell him about geology, but it is not sufficient to stop there; it is essential to advance the available proof that dowsing, of itself, and theory aside, does not work. It is to the author's credit that, by and large, he has done this, but the exceptions, although they may make the book more entertaining, do not add to its stature.

If we are to scotch the dead ends of technology, the mystic short cuts that offer a short, circular, and endless path from honest perplexity and groping to empty simplicity, it will be necessary to see the thing for what it is, and use the exposure of eccentric or paranoic personalities, of meaningless or extravagant syntax, only as auxiliary tools. Such tools are always useful to entertain a reader, or to sustain a conviction, but that conviction must first and always be based on the evidence.—D.N.F.

How to identify wrought-iron pipe is the subject of a folder distributed by A. M. Byers Co., Clark Bldg., Pittsburgh, Pa.

High-capacity "Texrope" V-belts are described in a 4-page bulletin, 20B7786, distributed by Allis-Chalmers Mfg. Co., 1026 S. 70th St., Milwaukee, Wis.


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Condensation

Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *BH—Bulletin of Hygiene (Great Britain); CA—Chemical Abstracts; Corr.—Corrosion; IM—Institute of Metals (Great Britain); PHEA—Public Health Engineering Abstracts; SIW—Sewage and Industrial Wastes; WPA—Water Pollution Abstracts (Great Britain).*

POLLUTION CONTROL

Water Pollution Research (1951). Report of the Water Pollution Research Board (England). This report covers research in water, sewage, industrial waste, and polluting effects of sewage and industrial wastes. Each subject is reported separately. *Water.* More economical or efficient method of treating water to prevent boiler scale is desired. By passing water between 2 electrodes, it was hoped sludge would be formed instead of scale, or at least cause scale to adhere less firmly. Expts. thus far did not indicate desired results, but did reveal that, under identical conditions, wide discrepancy in physical character of deposits and proportions which could readily be removed was observed. Report indicates much longer, detailed investigation is necessary. *Sewage.* Fate of radioactive substances during treatment of sewage: Radioactive isotopes—sodium 24, phosphorus 32, cobalt 60, bromine 82, and iodine 131—when added to sewage as an inorg. salt in lab. tests were not adsorbed on sludge during primary sedimentation. In percolating filter and activated sludge, sodium, bromine, and iodine appeared in about same concns. in effluent. Phosphorus was strongly adsorbed, but because of its short half-life, there would be no danger. Cobalt, with longer half-life, and being adsorbed, would have to be limited in sewage. *Industrial Waste Waters.* Manufacture of penicillin: Waste liquid from manufacture of penicillin is highly polg. product and is very favorable for growth of microorganisms. Filtration at very low rates with recirculation produced excellent effluent in lab. expts. Treatment by aeration was unsuccessful as diffusion plates became clogged by biol. growth and frothing was encountered. Waste waters containing cyanide: Small scale expts. using coke filters were conducted to det. effect on sewage containing simple cyanides and complex metallic cyanides. Some satisfactory results were obtained but not in all expts. *Polluting Effects of Sewage and Industrial Wastes.* Toxicity to fish: Data on continued expts. on survival of rainbow trout in cyanide concns. varying from 0.07 to 2.0 ppm have been assessed to det. significance of departures from fitted curves. Bacteria in pold. waters: Report indicates that more accurate method than presumptive test for *Esch. coli* is desired when testing for poln. of river waters. Investigations show that large proportion of cells of *Esch. coli*, Type I, are incapable of growing on bile salts media if usual technique is followed. It was found that organisms which had been immersed in dilute buffer solution were resuscitated or rejuvenated and thus correctly included in estd. count. Expts. were conducted to det. effect of pH and nutrients on viability of *Esch. coli* and *S. faecalis* under controlled conditions. Conclusions were that both organisms were least viable at pH 6–7, increased appreciably at pH 7.6–7.7, and still greater at pH 5.0–5.2. *S. faecalis* not significantly affected by oxygenation but *Esch. coli* died much more rapidly under anaerobic than aerobic conditions. Period of survival and growth for *Esch. coli* was directly related to concn. of nutrient added. Mixed strains showed greater tolerance at very low dosages. Streptococci required higher doses than *Esch. coli*.—*PHEA*

The New Gas Transmission Lines in Massachusetts in Relation to Public Water Supplies. R. M. Soule. J. NEWWA, **66**: 228 ('52). Author describes location of various high-pressure natural-gas transmission lines in Massachusetts, and discusses whether such lines constitute hazard to public water supplies. Massachusetts Dept. of Public Health has recommended that no gas transmission line should be located within 400′ of any well used as source of public water supply or within 50′ of high-water

(Continued on page 66)

(*Continued from page 64*)

mark of any surface water source of supply, or any tributary thereto, without special approval of health dept. Various situations are cited in Monson, Lowell, Hamilton, Cambridge, and Wellesley.—*PHEA*

Contamination of Ground Water Supplies by Gasoline. Josef Muller. Gas- u. Wasserfach, **93**: 205 ('52). 2 case histories given where considerable quantities of gasoline escaped into ground. Gasoline odor was detd. in wells to max. distance of about 3 km, but over somewhat limited area, and considerable time elapsed before it reached wells at greatest distance. Some persons can detect gasoline in water at concn. of 1:1,000,000; it can generally be detected at 1:500,000 and is quite noticeable at 1:100,000. In one case, gasoline contained $PbEt_4$, but in no case was Pb concn. greater than 0.5 ppm detected in well water, and this in only 1 sample; other concns. were 0.1 ppm or less. No danger of Pb poisoning was present, as water contg. perceptible quantities of gasoline was completely unusable for domestic purposes. Coincident with appearance of gasoline in wells, nitrates could no longer be detd., and only traces of nitrites. As gasoline odor diminished, nitrates gradually increased to their normal value, latter being reached sometime after odor had disappeared. With lowering of ground water level, lighter gasoline was absorbed by soil in 1 instance, to be evident again during high water. Gasoline in soil appears to be oxidized first by atm. O and then by means of nitrate with aid of catalytic or biol. process. CO_2 and N are formed, former reacting with Ca compds. to increase alky. and hardness of water. When only slight traces of gasoline remained in water, active C filters were successfully used to purify water for domestic purposes.—*CA*

Stream Pollution Resulting From the Use of Organic Insecticides. L. A. Young & H. P. Nicholson. Prog. Fish-Cult., **13**: 193 ('51). In Aug. '50, fish kills occurred

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in at least 15 streams in Tennessee R. Valley of Alabama. Investigations indicated that kills resulted indirectly from application of insecticides for control of cotton insects. These are first instances known to authors in which extensive poln. of streams has resulted from use of insecticides in agriculture. In '50, insecticides containing toxaphene, benzene hexachloride, DDT, and aldrin became widely used on cotton for first time in this area. Frequent showers during dusting season necessitated reapplication of insecticides at shorter than normal intervals, with resultant large concns. on soil of cotton fields. Several heavy rains in August presumably washed into streams sufficient insecticide to eradicate fish life from some streams and cause lighter kills in others. Kills followed shortly after heavy rains and were associated with high water levels and increased turbidities. Stream poln. resulting from employment of organic insecticides in agriculture may become increasingly serious problem. Insecticides now employed for control of cotton insects, and recommendations for their use should be reevaluated in attempt to prevent further similar occurrences. Every effort should be made to prevent individual farmers from applying insecticides in excess of quants. recommended.—*SHW*

Pollution in Water Supplies From Shallow Wells and Measures for Its Prevention. N. R. Knowles. Proc. Soc. Applied Bact., **13**:2:92 (Oct. '50). This is good account of improvement that can be achieved in bact. qual. of water from shallow wells when close attention is paid to constr. of wells to prevent ingress of poln., provided site of well is satisfactory. Important features to be considered in construction of shallow wells are siting in relation to flow of underground water, provision of waterproof lining for upper portion of shaft, and protection of well head and its immediate surroundings. Practical work in this investigation included observations on bact. qual. of water from 3 wells before and after renovation, together with examn. of 48 other wells. Samples were taken directly from wells by means of sinker type water-sampling outfit. Samples were transported to labs. within 3 hr and those not tested immediately were stored in cold room until examd. on following morning. 3 wells that were specifically considered contained coli-aerogenes organisms capable of fermenting lactose at 44°C in vols. of 1 ml or less, in samples collected before improvements were carried out. Renovations consisted in lining wells with concrete blocks, cemented together at joints; and head of well was carried above ground level and provided with sealed manhole cover. Where protruding shaft of yard well was serious obstacle, concrete apron sloping away from well was provided. Samples from these wells collected after renovation showed that within few months qual. of water reached satisfactory standard of being negative with regard to presence of coli-aerogenes organisms in 20 ml. Bact. examn. of group comprising 48 new and renovated wells showed that they could be clearly divided into categories according to bact. results obtained, and these were correlated very closely with findings on inspection of well surroundings and state and construction of well. Results from yard wells were generally unsatisfactory and it is suggested that practice of sinking wells in yards or close to farm buildings should be discontinued. Other factors found to contribute to poor qual. of water were failure to cement joint linings and pipe holes, to provide impervious lining of sufficient depth, and to carry well head above ground level.—*BH*

Pollution Control of the Rio Grande in New Mexico. R. P. Lowe. Sew. & Ind. Wastes, **24**:1021 ('52). Using as background fact that demand for use of all available water in New Mexico, Colorado, Texas, and Mexico necessitates close control of poln. in Pecos and Rio Grande rivers, author describes briefly natural drainage area, normal flow, uses of water, current shortage problems, poln. loads, and remedial action taken. 3 interstate river compacts are active in control activities. Wastes from atomic energy industries present special industrial wastes difficulties. Alert control should prevent development of major problems.—*PHEA*

Efficiency of Filter Beds for Treating Radioactive Waste. Lee Gemmell. Nucleonics, **10**:40 (Oct. '52). Report on studies to det. eff. of intermittent sand filter beds in removal of some common radioisotopes in influent to Brookhaven Natl. Lab. sewage disposal plant. Raw waste is composite of sanitary sewage, usual lab. wastes

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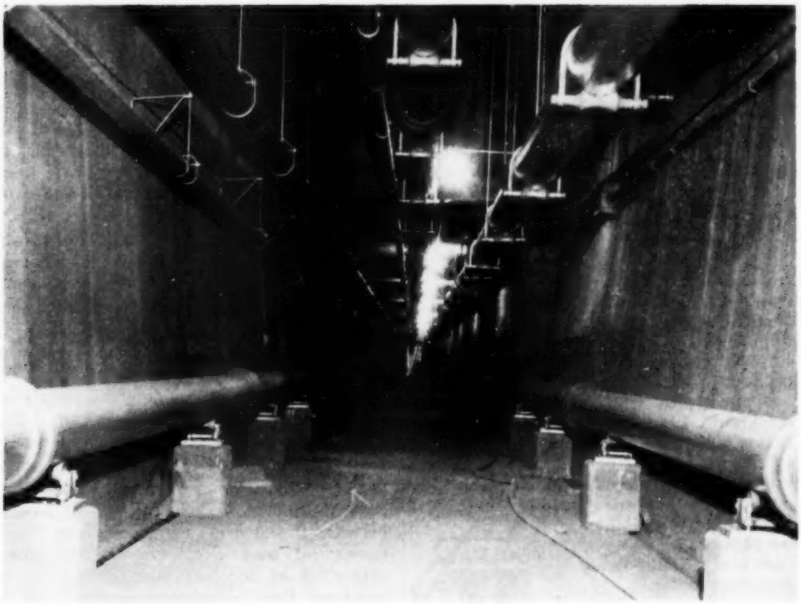

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and low-level radioactive wastes produced in BNL and is low in suspended solids. Treatment units consist of Imhoff tank; 25,000-gal dosing tank; six 6′ intermittent sand filters; settling tank and chlorinating machine. Activity levels (curies/cc) of influent to and effluent of filters are measured. Known quants. of specific isotopes of P^{32} in form of HP_3O_4, I^{131} in weak basic $NaSO_3$ solution, Sr^{90} as acid chloride, and 6-month mixed-fission products as NO_3 were applied to test filter. Table is presented which shows amts. of activity applied to this filter, that picked up by tile underdrainage system, and that lost to sand and ground water. Tests were also conducted to ascertain location of adsorbed activity within filter bed. These indicated that approx. 90% of total activity removed was adsorbed within 3 in. of surface where concn. of org. and inorg. materials is highest; approx. 98% of total was adsorbed between 0 and $-1'$ and only about 2% between $-1'$ and $-6'$. Question of possible saturation of bed was also studied. It was observed that percentage removal eff. decreased with increased resistivity to flow (time), decreased removal eff. partly attributable to washing through of loosely adsorbed activity and to dosage rates. Tests of removal eff. on wastes containing different study isotopes all indicated fluctuations in activity removal eff. for any single waste as well as variation between wastes but never did it fall below 50% under controlled test conditions. Concluded that it was unlikely under present low-level dosing conditions (not exceeding 3×10^{-12} curies/cc on avg.) that BNL beds would become satd. to point where activity removal eff. would be less than 50% and that, neglecting decay, satn. would not be reached before 1,000 yr or more. Author cautions that, because of complexity of variables and phenomena involved, data must be considered as incomplete and that results not necessarily applicable to similar conditions elsewhere.—*PHEA*

Significance of Radioactivity to Water Works Superintendents. ROLF ELIASSEN. J. NEWWA, **66**:260 (Sept. '52). Conventional water treatment processes will remove radioactivity present as anions, colloids, and particulate matter. If isotopes such as strontium and similar fission products should occur as positive ions after atomic explosion, they would not be removed readily by con-

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ventional processes, because special treatment will be required, using double coagulation and sedimentation. Thus, very few water treatment plants will be equipped to remove large amts. of radioactivity occurring as cations in times of disaster. However, chances of such contamn. are very remote and do not warrant expenditure of funds for treatment plant additions. Water superintendents can do greatest service to their communities by understanding basic principles of radioactivity, by reading related literature in technical journals, by knowledge of restrictions facing them because of fixed nature of plant, by having connections to number of sources of supply, such as adjacent communities or auxiliary wells, and by assuring their consumers that, in event of contamn., natural decay and diln. will substantially reduce amt. of radioactivity in matter of days. There is really not much one can do otherwise, from standpoint of removal of radioactivity from water. Through cooperation of state health dept., superintendents should be obtaining data on natural radioactivity in their raw water, if any detectable amounts are present. They can then be in position to evaluate extent of contamn. should any occur from bombing, lab. or medical uses, or from installations utilizing atomic power.—*PHEA*

Radioactive Contamination, Continuing Problem in Water Supply Engineering. R. J. Morton. Civ. Eng., 22:722 ('52). Radioactive contamination of water supplies may result from lab. or military use of nuclear fission. Max. permissible concns., prevention and control measures, and radioactivity-measuring devices are discussed. Extensive bibliography is presented.—*PHEA*

Radioactive Waste Disposal to Public Sewers. F. W. Kittrell. Sew. & Ind. Wastes, **24**:985 ('52). Sample calcns. are given to illustrate methods of safe disposal of radioactive wastes into sewers.—*CA*

How to Survey a Stream for Radioactive Substances. O. W. Kochtitzky & O. R. Placak. Pub. Wks., **83**:6:76 ('52). In streams receiving wastes originating from naturally occurring radioactive materials, operating nuclear reactors, hospitals or research organizations, industrial areas, or atomic explosion, radioactivity levels should be detd. on water, sediment, aquatic life, and immersed objects. Continuous monitoring for gross counts with counting instruments discriminating between types of radiation is desirable. Concn. of samples before examn. is necessary for dil. contamn.—*CA*

Experiments on the Purification Capacity of Soil. J. K. Baars. Research Inst. Public Health Eng. T.N.O. (Neth.), Rpt. No. 16 (Aug. '52). Studies on purif. capac. of virgin dune soil sparsely covered with low scrubs and grasses, dune soil with settlement of sea gulls, and sandy soil from tourist camp with about 450 cabins, water from wells and pit privies. Analyses for NH_3-N, NO_2-N, NO_3-N, and O concns., and coliform organisms to 2-m depth. In virgin dune soil, no important changes in NH_3 and NO_2, decrease in NO_3 and O concns., coliforms in soil detectable below 1 m. In sea gull settlement, similar results although NO_3 content was several times higher. In tourist camp mineralization products more intense and could be detected in greater concn. and at greater distance from place of deposit. During winter months 75% of impurities disappeared from upper 2-m layer. In dry, sandy soil, bacteria were strongly absorbed; 4 months after camping season no typical *Esch. coli* were detected 40 cm from pit privy. After 7 months still further decrease. In expts. samples collected from dry soil with low ground water levels; where fecal contamn. reaches ground water *Esch. coli* could be detected after 2–3 yr without material change. No generalizations can be made without further study.—*Willem Rudolfs*

ADMINISTRATION AND FINANCE

Water Rate Structures. H. Randle. Munic. Util. (Can.), **88**:10:37 (Oct. '50). General principles discussed. Both water and elec. utilities sell service primarily and commodity secondarily, and latter utilities have long recognized 3 types of costs: [1] ready-to-serve, [2] rate of use, [3] quantity use. Service charge should pay for capital works and be very high percentage of total charge, except for very large consumers. Rate of use minor factor for domestic consumers but important for large industrial users and fire protection systems. Quantity charge should pay cost of pumping and

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treatment, and usually amts. to not more than ⅓ total, except for large users. Cost of public fire service should be billed to municipality and recovered through taxes. Following steps recommended in design of rate schedule: [1] det. increment cost to supply unit quantity; [2] if rate based on [1] will permit waste, increase rate; [3] det. revenue to be obtained from quantity charge and deduct it from total revenue required, exclusive of hydrant rental and other special revenue; [4] distribute remainder according to meter or service size and bill as service charge; [5] calc. special and avg. bills and, with social consciousness and knowledge of public reactions, make any necessary adjustments; and [6] charge adequately to enable good service and discourage waste. **Discussion.** J. W. D. Farrell. General practices to which public accustomed should be recognized. Social consciousness important. Large quantity expected to sell for lower unit cost. Service charge not popular and should be disguised or modified. Acceptable and easily administered schedule not likely to be scientific rate but compromise. Costs for rate making should include some payment to city for general administrative services and sum in lieu of taxes and should provide moderate replacement fund. Rates in larger western Canada cities outlined. D. G. Hoskin. Rates should be fair to consumer and also to water dept. Per capita consumption in Saskatoon, Sask., increased from 75 to 109 gpd in 20 yr. Rates, unaltered since '10, have produced $1,147,000 surplus in last 10 yr which reduced mill rate and helped defray municipal costs—in addn. to $143,000 paid in taxes. But in last 3 yr, issue of $703,000 debentures necessary and in excess of $250,000 required in near future. No depn. reserve. Long-term plan and public relations program needed to obtain more satisfactory financial setup.—*R. E. Thompson*

Unified Control Over Water, Sewage, and Storm Drainage in Toronto [Ont.] Area. William Storrie & Norman G. McDon-

(*Continued on page 76*)

(Continued from page 74)

ALD. Wtr. & Sanit. (Can.), **88**:8:19 (Aug. '50). Report to Toronto and York Planning Board concerning water supply and sewage disposal in Toronto and 12 surrounding municipalities. Three of latter have well supplies but dependable underground supply for whole area of order of 10 mgd only. Rivers and creeks comparatively small and heavily polluted, hence L. Ontario only source of adequate supply for metropolitan area. Practically all 12 sewage treatment plants in area overloaded. Recommendations include: [1] Single authority to coordinate and control water supply, sewage disposal and storm water drainage. [2] Toronto water purif. plants should ultimately supply most of metropolitan area. Capac. of R. C. Harris plant can be doubled (to 200 mgd) by extending filter plant, adding pumps and laying second intake pipe. New Toronto and Scarborough filter plants, also treating L. Ontario water, and well supplies of Etobicoke, Weston and North York should be retained but not extended, except for immediate needs. [3] No. of water purif. and sewage treatment plants should be kept to min. [4] All future sewers should be of separate type, storm water being discharged into nearest watercourse after short sedimentation period. [5] Establishment of policy on sewage treatment in whole area. [6] All sewage treatment plants should be of complete-treatment type, removing min. of 90% suspended solids and BOD, and effluents chlorinated during summer months. [7] Greater control over discharge of sewage and oil from vessels. Details of supply mains, booster stations, etc., required included. Constr. cost estd. at $23,570,000, of which $5,425,000 for water works.—*R. E. Thompson*

Municipal Improvement Corporation, Ontario. ANON. W.W. Inf. Exch.—Can. Sec., AWWA, **7**:4:D:11 (Feb. '50). Brief extracts from recently enacted bill of Ontario legislature establishing crown corporation for purchasing debentures issued by municipalities for water works and other sanitary improvements. Object to enable municipalities to borrow at low interest rates. Corporation may borrow up to $50,000,000 outstanding at any time and province may authorize treasurer of Ontario to guarantee payment of any debentures, bills or notes issued by corporation. All municipal debentures must be approved by municipal board.—*R. E. Thompson*

Water and Sewerage Financing and Accounting. R. S. GILLESPIE. Munic. Util. (Can.), **88**:10:38 (Oct. '50). General discussion, with particular reference to practice in Red Deer, Alta., where elec., water and garbage disposal charges billed together, using mech. bookkeeping machines and addressograph. Hydrant rental $50 per yr. Uniform method of accounting for municipalities set up by dominion and provincial govts. followed.—*R. E. Thompson*

Handling the Critical Materials Problems in a Water Department. H. J. GRAESER. Pub. Wks., **83**:69 (Apr. '52). Describes methods used in Dallas to provide adequate and ready supply of materials for maintenance and small force-account construction on water and sewerage activities. Heart of any materials problem lies predominantly in planning, purchasing, and use control. Buying in large quants. where possible, making use of new materials, and searching for new sources are worth-while activities in maintg. adequate stock of supplies. With aid of master plan, it has been possible to program major improvements and order material in anticipation of actual work. Lead, copper, and steel are materials most difficult to obtain. Substitutes for some items include cement-lined steel pipe, plastics, concrete meter boxes, and neat Portland cement pipe joints. Last mentioned material has been used with particularly good success in place of lead joints when properly installed. Practice of preventive maint. deals with anticipation of plant breakdowns and material shortages by careful and consistent checkups. Proper stock-keeping will prevent losses due to carelessness and theft.—*PHEA*

Plans, Records, and Storekeeping for a Water Distribution System. W. R. MOUNT. Munic. Util. (Can.), **90**:2:34 (Feb. '52). Records should be simple, flexible, readily reproducible, and capable of expansion without starting at beginning again. Records of jobs, new work, renewals, or maint. should begin with instructions to start work, responsibility for finalizing being that of central recording section. Edmonton, Alta., maintains following plans: [1] set for whole system, scale 100′ to 1″, 24″ × 17″

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overall; [2] for areas of first-class fire limits, addnl. set 50′ to 1″; [3] "balloon" plans, with references on record plans, for complicated or unusual situations; [4] wall maps, 500′ to 1″; [5] diagrammatic maps of mains, 1,000′ to 1″. Fire hydrants recorded numerically on cards and loose-leaf sheets and on maps. Valves recorded numerically in loose-leaf books and on maps. Services numbered and recorded on plans, cards, and loose-leaf slips. Meters on cards. Materials cataloged and continuous inventory maintd. Business machine used for recording in triplicate materials issued to and received from foremen and crews.—*R. E. Thompson*

How Self-liquidating Utility Projects Are Financed in Alberta. E. H. Davis. Munic. Util. (Can.), **90**:4:34 (Apr. '52). Since discovery of oil on plains, provincial govt. has large new source of revenue. Oil being wasting asset, policy established whereby this revenue used for capital assets which will be heritage for future generations. Accordingly, govt. has made available funds to be used specifically for self-liquidating projects, such funds to be repaid and used for further projects of like nature. Majority of projects so financed are water and sewage systems. Statutory limit, as in other provinces, is 20% of total assessed value of community. Local improvements, assessed against abutting properties, not included in limit. Under Self-liquidating Projects Act, loans, at 20%, are usually for 20-yr period. Projects, therefore, amortized at slightly more than 6%/yr. As borrowing rate for smaller communities is about 4.5%, act effects annual savings to community of 18.5–26%, avg 22.5%. By this scheme, purchaser of community debentures is, in effect, provincial govt. instead of financial institution. Procedure followed is described, including form of application for loan, est. of cost and revenue, and agreement between community and govt.—*R. E. Thompson*

(*Continued on page 80*)

(Continued from page 78)

Financing of Municipal Water Works and Sewerage System. R. L. LANE. Munic. Util. (Can.), **90**:4:25 (Apr. '52). General discussion, with special reference to Saskatchewan. Shift in pop. from rural to urban communities has increased demand for convenience of tap water and modern sewage disposal and thereby created financial problem. In Saskatchewan, legal borrowing limit for city is 20% of taxable assessment, for town 15%. This approach presupposes no local manipulation of assessments and is rather meaningless unless considered in conjunction with ability and willingness of taxpayers to pay tax rates imposed. Borrowing for mains and sewers, except at intersections, secured by special assessments and excluded from legal limit. Possible sources of revenue include: [1] special assessments on abutting properties; [2] special taxation of non-abutting properties benefited, e.g., by fire protection; [3] sale of water; [4] meter rentals or service charges; [5] hydrant rentals; [6] sewer rental fees. Revenue should be sufficient to meet: [1] debt service; [2] all operating costs; [3] repair and maint.; [4] reasonable working capital reserve; [5] surplus to meet budgetary requirements of municipality.—*R. E. Thompson*

Water Law in the United States. S. T. HARDING. Civ. Eng., **22**:696 ('52). Water law in U.S. derives from old English common law riparian rights and appropriation system developed by early mining and irrigation interests in West. As water demand has increased, especially in arid West, new applications and controversies have developed. Problems, present needs, and probable future trends in ground and surface water regulations are discussed in view of local, state, and federal govt. interests.—*PHEA*

Water Works in Civil Defense. G. E. MCCALLUM, M. D. HOLLIS & H. F. LUDWIG. Pub. Health Rpts., **67**:492 ('52). Discussion of current situation in civil defense with respect to public water supplies, with emphasis

(Continued on page 82)


WATCH DOG

(Continued from page 80)

on benefits that have accrued to water works from joint community, state, and federal efforts to develop civil defense program within framework of self-help policy. Subjects discussed include: federal role, with notes on pending technical manual to be issued by U.S. Civil Defense Admin.; activities of CDA regional offices, which are now filling their professional staff positions; community responsibilities; importance of water supplies; and significance of special weapons.—*PHEA*

A Safe Water Supply in Civil Disaster. G. E. McCallum, W. E. Holy & H. F. Ludwig. Pub. Health Rpts., **67**:631 ('52). Discussion of problems involved in maintg. safety of public water supplies during civil defense emergencies, with special reference to prepn., processing, and distr. of food. Subjects considered are types of water supply contamn., including contamn. by special weapons, detection of contamn., decontamn. measures, and emergency water supplies.—*PHEA*

Civil Defense for New Jersey's Water Works. A. Greenberg. Pub. Wks., **83**:73 (Apr. '52). In accordance with law passed in '49, governor, head of civil defense, is authorized to establish organization to control and direct state's resources to cope with any emergency. 4 dists., divided into 13 defense areas, are under supervision of state director of civil defense, who is vested with all powers of governor in dealing with any emergency when declared by governor. Realizing that effect of enemy action on water works may endanger health of very large proportion of populace, "Joint Operations Board" is working out methods to provide safe and adequate water service throughout state. These cover mapping of water systems, sources, emergency water transportation, disinfection, and emergency connections between communities combating effects of atomic, chem., bact., and biol. contamn. Routine examn. of water samples for: coliform organisms and total bacteria; pH; taste, odor, color, and turbidity; nitrates, chlorides, and sulfate; chlorine demand; oxygen consumed; and cyanides and alkaloids. Consideration will probably be given to use of new membrane filter in bact. work as soon as this method becomes commercially available. Any emergency that may occur will be serious challenge to public health activities. Intense prepn. and planning for such emergency will have long-range value in terms of permanent public health progress, as best prepn. to deal with emergency is strengthening of routine public health programs.—*PHEA*

BACTERIOLOGY

Antibiotic-producing Species of *Bacillus* From Well Water. R. H. Weaver & Theodore Boiter. Trans. Ky. Acad. Sci., **13**:183 ('51). Members of genus *Bacillus* that are antagonistic for *Esch. coli* were isolated from samples of water from 24 of 32 Fayette County, Ky., wells. Of 39 isolates identified, 15 were *B. subtilis* and 13 *B. cereus*. *B. cereus* isolates had slightly broader zones of inhibition for *Esch. coli* than did *B. subtilis* isolates at time of isolation. When tested 12-18 mo. later, however, they had almost completely lost their antibiotic-producing ability, while *B. subtilis* isolates had retained theirs. Almost all *B. subtilis* isolates also produced antibiotic action against *Shigella flexneri*, *S. typhosa*, *S. paratyphi* and *Micrococcus pyogenes* var. *aureus*. Although data presented inadequate to determine significance of *Bacillus* spp. in connection with longevity of coliforms in water, demonstrated prevalence of potentially antagonistic strains indicates that they may have some significance.—*PHEA*

Use of Rosolic Medium and of Growth Stimulants for Determination of Fecal Contamination of Water. K. S. Kichatova. Gigiena i Sanit., **1952**:6:40. Rosolic medium more sensitive than fuchsin-sulfite agar for bacterial growth. Used in conjunction with growth stimulant consisting of yeast lyzate, it gave detectable, useful results within 12 hr.—*CA*

Application of the Investigations of Bacteriophages to the Study of Polluted Waters. I. The Survival of Enterobacteriacea in Water. II. Bacteriophage of Large and Small Bodies of Water. A. Guelin & J. Gozdawa-Le Bris. Ann. Inst. Pasteur, **82**:78 ('52). Survival of Enterobacteriacea in water and activity of bacteriophage (I) were studied. Polluted waters from various sources (sea, river, pond, or NaOCl-treated) cultured. Daily counts made of bacteria introduced from these sources showed no in-

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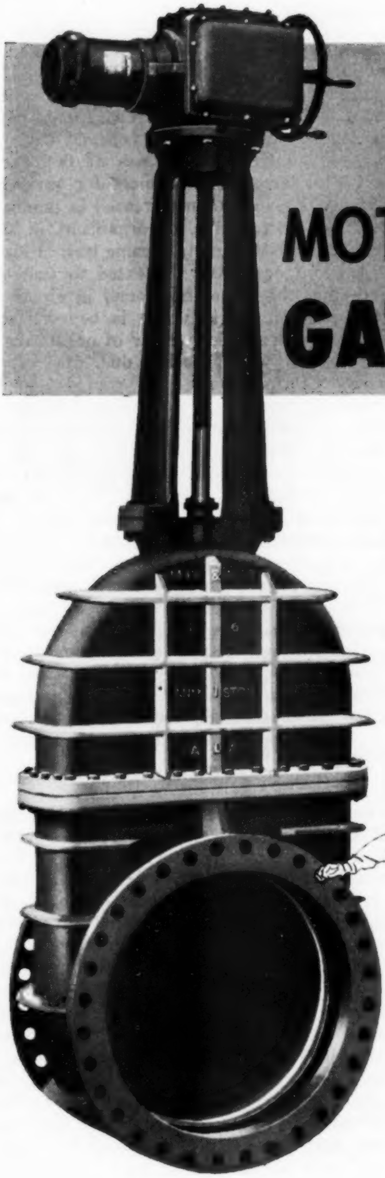

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(Continued from page 82)

crease of bact. titer. Count decreased progressively for first few days and then dropped abruptly toward 7th day. This sharp decrease accompanied by rapid clearing of medium, often observed within few hours. This phenomenon absent in autoclaved water. Even after disappearance of living organisms, medium remained as turbid as at start. Furthermore, bacteria remained for weeks or even months with no sharp drop in titer after 7 days. *Salmonella* I from large isolated bodies of water were quite specific, while I from small bodies were very multivalent, attacking coli-typhoid-dysentery group of organisms.—*CA*

Regularities in Growth of Saprophytes During Self-Purification Processes in Polluted Streams. E. V. Dianova & A. A. Voroshilova. Mikrobiologiya, **21**:311 ('52). Self-purif. of pold. streams follows curves closely resembling curves of bact. growth in favorable media, and with like seasonal changes. Chem. data such as BOD and mineralization of org. compds. give accurate indications of rate of self-purif. and offer means of checking bact. growth curves or max. points on such curves.—*CA*

Viability of Coliform Organisms in Estuary Water. T. C. Buck Jr., C. E. Keefer & Hester Hatch. Sew. Ind. Wastes, **24**:777 ('52). It should be emphasized that lab. conditions are vastly different from those occurring in nature. Any interpretation of results of such lab. studies should be made with extreme caution. Both *Esch. coli* and I.A.C. organisms present for much longer periods of time than originally anticipated. Investigations confirmed some observations made by Metropolitan Water Board of London and by Bigger. Estuary water, both autoclaved and unautoclaved, when retained in lab., was capable of supporting coliform organisms for prolonged period. This statement applied to distd. water inoculated with these organisms. Assuming that conditions in field generally similar to those in lab., it would seem reasonable to expect that coliform organisms, once introduced into estuary, would be present for long periods, provided their number not reduced by such factors as sedimentation, predatory protozoa, excessive acidity or alkalinity, or various toxic compds. Fact that decrease in number of *Esch. coli* and I.A.C. organisms was followed in several instances by increase in number is of interest. This cycle, involving decrease and then subsequent increase in numbers, occurred at least twice in several bottles. It is believed that, as bacteria died off, protoplasm of their cells served as source of nutriment for surviving organisms, which then increased in numbers. As rule, max. concn. of organisms in successive cycles gradually became less. Finally number of organisms decreased to such degree that they were not found in either 1-, 10- or 30-ml portions. It is believed that eventual decrease in number of organisms in all samples was probably due, at least in part, to formation of toxic compds., to decrease in food supply, or to combination of these 2 factors. It is definitely known that when coliform organisms grow on number of media, they produce toxic substances that result in death of organisms. Similar toxic substances may have been produced in 10 water samples under investigation. Decrease in food supply for sustaining life cycle of surviving cells seems apparent, as protoplasm of dead cells, which consisted in part of carbohydrates, fats, and protein, was converted through system of complicated biochemical reactions into carbon dioxide, hydrogen, ammonia, water, and other compds. These materials could not be reused as source of food supply by coliform organisms.—*PHEA*

Processes Contributing to the Decrease of Coliform Bacteria in a Tidal Estuary. B. H. Ketchum, J. C. Ayers & R. F. Vaccaro. Ecology, **33**:247 (Apr. '52). Distr. of salinity, oxygen, and bacteria in Raritan R. described. Method presented for evaluating relative effects of diln., bactericidal action of sea water, and predation in reducing pop. of coliform bacteria in tidal estuary. Shown that these 3 processes account for more than 99% of decreases in coliform bacteria in Raritan R. Bactericidal action is most important process, followed by predation and dilution. Unevaluated processes contributing to decrease are more important than diln. or predation but much less important than bactericidal action.—*PHEA*

The Effect of Storage on the Coliform and *Bacterium coli* Counts of Water Samples. Overnight Storage at Room and Refrigerator Temperature. Commit-

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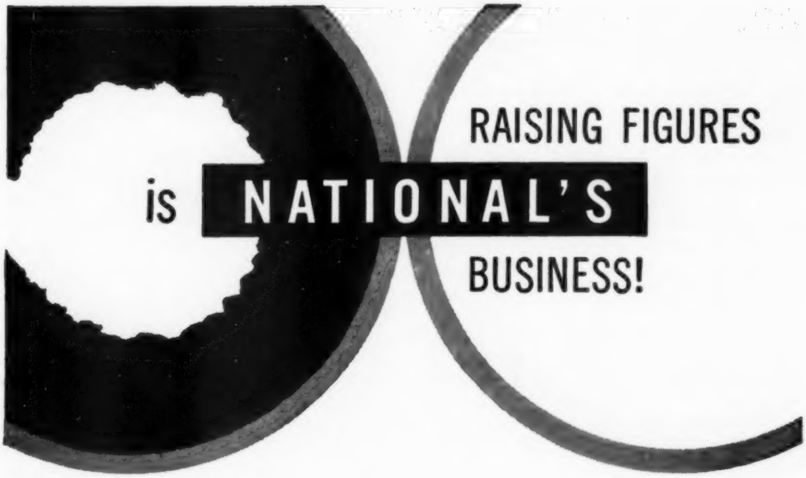

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(Continued from page 84)

TEE REPORT. J. Hyg., **50**:107 (Mar. '52). This investigation has been concerned with changes that occur in coliform and fecal coli content of water samples in storage at room and refrigerator temp. for 20–24 hr. On examination by 70-tube method, using two-fold diminishing vols., 23 out of 151 samples of water stores overnight at room temp. showed significant increase in presumptive number of coliform organisms, and 29 showed significant decrease. Of 151 stored in refrigerator, 10 showed significant increase and 26 significant decrease. Of 111 samples examined for fecal coli, 8 showed significant increase on storage at room temp. and 29 significant decrease. Of same number stored in refrigerator, 7 showed significant increase and 15 significant decrease. Effects of source of water, time of year, and original number of coliform organisms in sample were examined. Present investigation has shown that in considerable proportion of samples significant change in coliform and fecal coli content does occur on overnight storage at room or refrigerator temp. It may, perhaps, be safe to store samples under some conditions for shorter periods, but this is matter for future investigation.—*PHEA*

The Bacteriological Examination of Water. R. C. HOATHER. J. Inst. Wtr. Engrs. (Br.), **6**:426 ('52). Particularly with reference to stability of number of coli-aerogenes, including *Esch. coli,* during storage of samples overnight. Effect of storage at different temp. on coli-aerogenes pop. of samples of water has been subject of number of investigations, but some inconsistencies have appeared in results. Present work is mainly investigation of effect, if any, of storage for 24 hr. 140 samples studied all related to public water supplies over period of 12 mo. which contained coli-aerogenes organisms and were conveniently available for examn. on day of sampling and following day. Feature of results is absence of noticeable proportion of very large variations (particularly decreases). Of 4 groups (coli-aerogenes and

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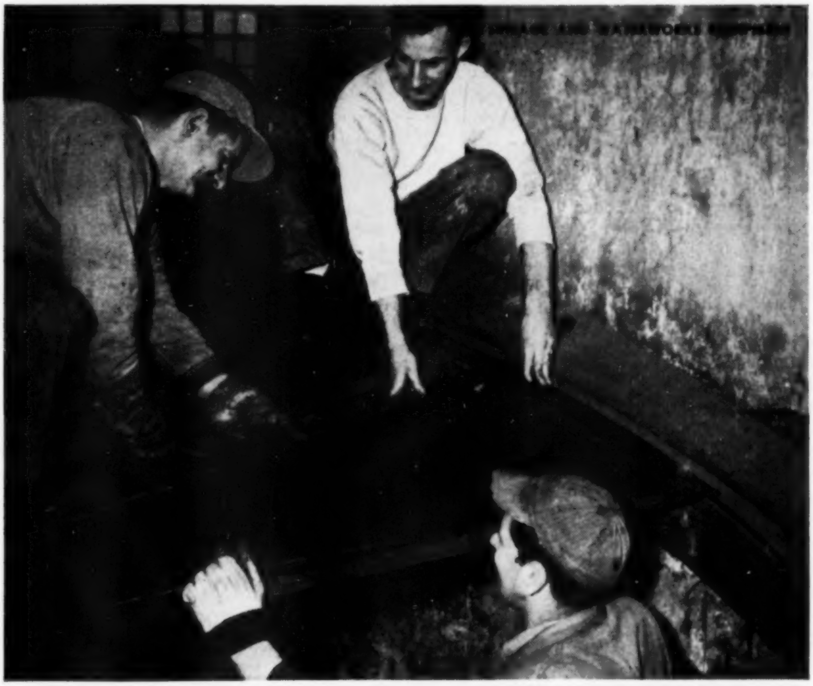

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(Continued from page 86)

Esch. coli at 5° and 25°C) only one giving indication of change in number of organisms from first day to second day was coli-aerogenes at 5°C. Even for this group, difference not significant at 5% level. All observations so far discussed were made using bacteriological sampling bottles containing sodium thiosulfate. There may be some advantage in use of this apart from purpose of removing residual chlorine. Consistency of results suggests that, if large change is found when sample of water is stored for 24 hr., there must be specific cause for such change. Such cause may be presence of chromates, copper, or zinc. Chromic acid cleaning solution is widely used for bacteriological apparatus. There is real danger of speck being left in sampling bottle. With increasing use of copper for service pipes, possibility of copper derived from pipes interfering with bact. examns. needs to be considered. A few ppm of zinc is liable to be found in samples taken from galvanized cisterns. Small amt. of disodium hydrogen phosphate previously added to sample bottle will ppt. metals and stop their action at time of sampling, provided calcium content of water not too low for ppn. For public supplies, interference arising from Cu and Zn will rarely occur. Examn. for *Cl. Welchii* is useful as additional indicator of fecal poln., particularly where *Esch. coli* may have died off under natural conditions in water or have greatly multiplied.—*H. E. Babbitt*

CHEMICAL FEEDING, CONDITIONING, AND SEDIMENTATION

A Year's Operating Experience With "Decarbolith." HERST ECKSTEIN. Bergbau u. Energiewirt. (Ger.), **4**:175 ('51). "Decarbolith," prepd. by controlled calcining of West German dolomite, has been found effective for deacidification of water, and Fe and Mn removal. Earlier difficulties in prepn. and use have been elimd. Calcination

(Continued on page 90)

(*Continued from page 88*)

of dolomite should be controlled so that product has loss on ignition of at least 30% and not over 32%. Before use, product should be hydrated under water for some time, to insure complete removal of Fe and Mn. Controlled amts. of $Al_2(SO_4)_3$ should be added to waters with high humic acid contents to flocculate Fe and Mn, but excess should be avoided. Tables are available for estg. amt. of "Decarbolith" required for various conditions. When possible, water should be aerated before filtration. Filter should be washed only with purified water, or, if necessary, with raw water with low Fe and CO_2 content. Expts. are in progress on sterilization of "Decarbolith" with NaClO solns.—*CA*

Removal of Chlorine From Water by Activated Carbon. A. Y. Hyndshaw. Munic. Util. (Can.), **90**:2:27 (Feb. '52). Many manufacturers require water contg. no residual Cl; e.g., flavor of soft drinks adversely affected by free Cl. C not only dechlorinates but removes other tastes and odors. When Cl dissolved in water, HCl and HOCl formed. Latter slowly decomposes into HCl and O; C catalyzes this decompn. Some believe that nascent O formed subsequently reacts with C to form CO_2. Carbons differ in dechlorination eff. and attempt made to devise evaluating test. Dechlorination eff. does not parallel removal of chlorophenol (5 g/gal), nor other adsorptive tests, such as I removal. Direct measurement of dechlorination by C bed therefore studied. This introduces factor of particle size, as only external surfaces immediately available, and also with usual concns. of Cl, less than 5 ppm, life of C would be measured in months or even years. Accelerated test tried, consisting of passing water contg. 3,000 ppm downward through 12" C bed in 1" glass tube, continuing flow until tests of effluent at 15-min intervals showed 20% of original concn. This test distinguishes between good and poor C but presents difficulties in comparing carbons

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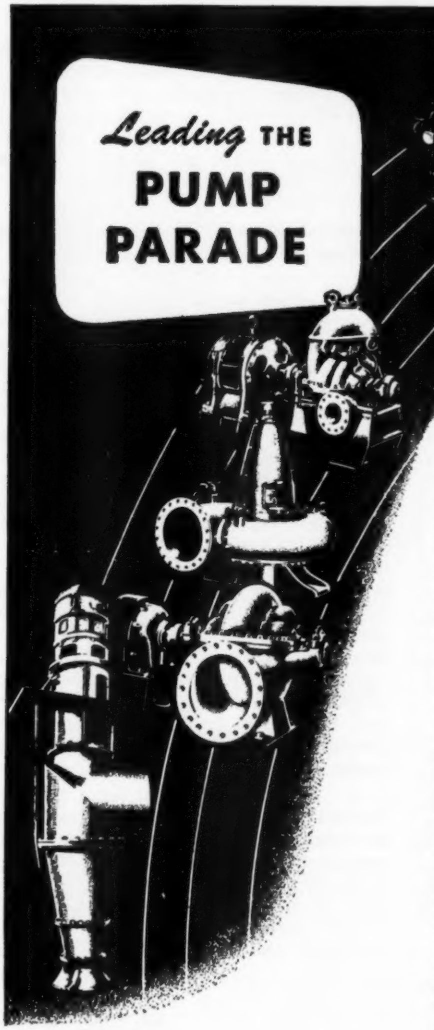

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(*Continued from page 90*)

approx. equal in eff. With some carbons, small residuals appear rather early in run, remaining fairly const. for appreciable time, while others show zero residual in initial stages and suddenly pass 600 ppm in much shorter time. Flow rates of 50–150 ml/sq in./min studied. Slower rates not only gave lower residuals but increased life more than 100%. Dechlorinating power partially restored by resting for short period. In general, dechlorination greater at pH less than 7 than at higher values. Above pH 10, some conversion to chlorate. Generally, C with higher eff. at one pH value also better at other pH values. With 3,000 ppm Cl in influent, pH decreased from 7 to 2 by HCl produced. Cl^- in effluent did not parallel decrease in Cl. At low pH, Cl^- present as HCl, which is appreciably adsorbed. At higher pH values, Cl^- present as metallic chlorides, which are adsorbed to much less extent, and therefore Cl^- more nearly corresponds to Cl removed. After resting period, Cl^- increased abnormally when operation resumed. Life of granular C for removing low residuals cannot be predicted by accelerated test described. Warning of exhaustion obtainable by periodic testing of water drawn from tap located at ⅜ of bed depth below surface.—*R. E. Thompson*

Cheap Way to Remove Fluorides From Water. J. A. Lee. Chem. Eng., **59**:7:211, 400 ('52). Inexpensive system for removal of damaging amts. of fluorides from public water supplies described. Raw water treated with activated Al_2O_3, which adsorbs or absorbs fluorides; Al_2O_3 then regenerated by washing successively with dild. NaOH and dild. H_2SO_4.—*CA*

Improvements to Sedimentation Tanks at the Lovo Water Works, Stockholm. Anon. Wtr. & Wtr. Eng. (Br.), **56**:216 ('52). Each of four sedimentation tanks at Lovo Water Works is 134′ long, 34′ wide, with avg. depth of 16′. Bottom slopes lengthwise downward toward inlet at slope of 1:19. Main innovation consists of false bottom so arranged that waterway, both above and below, converges in direction of flow. Deep baffle wall with shelf at inlet directs water to bottom of tank and sets up gentle countercurrent which brings back light particles of floc from more turbulent region under false floor. As constructed in '31, tanks had nominal output of 10.66 mgd (Imp.). In '45 author considered insertion of false floors had increased capacity to 25 mgd, without decreasing eff. below 80%. Capacity has now been enlarged up to 53.3 mgd by using activated silica as supplement to alum and without any alteration in tanks. —*H. E. Babbitt*

Effect of Velocity on Flocculation and Settling in Sedimentation Tanks. E. Knop. Gesundh-Ing. (Ger.), **73**:157 ('52). Author claims that clarification depends on capac. (detention time) of settling tanks and not on surface loading. From plant studies and scale-model plant expts. it is concluded that, in general, finely divided suspended solids visible under microscope are of greater importance, whether caused by clay, sewage, or water containing electrolytes. Clarification and flocculation can be favorably affected by slow water movement. When flocculation occurs in settling basin, detention time is important factor and quant. of suspended solids in effluent is function of detention time. Measurements of flow-through time of number of plants show that part of water may pass through in 10% of theoretical detention time. Long and flat-bottomed tanks give, in general, better flow relations and are less subject to disturbance than basins with large height-length ratios. Poorly operating tanks can be improved by baffling and slotting.—*W. Rudolfs*

Factors in Sedimentation as Exemplified by Calcium Carbonate and Silicate Sediments. C. W. Correns. Deut. Hydrograph. Z. (Ger.), **3**:83 ('50). Factors considered are: [1] surface distribution of plankton and diatoms containing $CaCO_3$ or SiO_2; [2] diln. of sediments by terrigenous materials; [3] effect of oceanic circulation; [4] soly. of $CaCO_3$ or SiO_2 as dead organisms fall to bottom; and [5] soln. and repptn. processes after sedimentation.—*CA*

OTHER ARTICLES NOTED

Recent articles of interest, not abstracted, are listed below.

Study of Physical Factors Affecting Flocculation. Elwood L. Bean. W.W.Eng., **106**:33 (Jan. '53).

Safety Program as Set Up for Corps of Engineers. J. C. Smith. W.W.Eng., **106**. 30 (Jan. '53).

(Continued from page 46 P&R)

Tanks won't be welcome long if they keep up the bad work with which they greeted 1953. "Up" is the word, too, for what in plain water words are called elevated steel water storage reservoirs have been causing all the trouble.

First, in Chicago, a 35,000-gal, 150-ft-high tank, owned by Wilson & Co., meat packers, ran up a $50,000 damage bill. The damage? All of it to the tank itself, the tank's insulating material having been ignited by sparks from torches used in repair work on its standpipe. Being empty for repairs, the tank couldn't douse itself. Being high, it kept the flames beyond the reach of the water aimed by the first fire-fighting units. Being a water tank, it almost curled up from shame if not from flame.

Next, in Point Pleasant, N.J., on a tank of the same height, a painter took a 30-ft plunge from a scaffold inside and ended up almost unmovable on the floor of the tank, his neck broken. It was a Navy helicopter, hovering over the tank, though buffeted by a strong wind, that was finally able to tie to a basket stretcher arranged by coworkers, raise it through a small opening in the roof of the tank, and drop with it to the ambulance waiting below.

Then, in Queens, New York City, a five-man wrecking crew at work demolishing an obsolete tank were almost wrecked themselves when they ran into a hoard of nuts guarded by two "ferocious" squirrels. With special permission from the State Conservation Dept. to shoot the beasts, the men were restrained by an ordinance against firing a gun within city limits. There the matter and the 125-ft steel supports stood for at least a week, while demolition men refused to go near those gnashing teeth and New York Nimrods snowed them under with suggestions.

Fires, fatalities, ferocity—and, not long ago, flood. What we need is a movement toward the alleviated cantankerousness of elevated tanks.

Hydrosynthesis is just what it sounds to be—the manufacture of water by plants. Aside from product, the only differences between this process and photosynthesis appear to be that the plants involved in hydrosynthesis are man-sized toadstools and the energy is derived from a radioactive pyramid instead of the sun. That this happens inside the Moon rather than outside the Earth * seems to make no difference at all to Junior, who, toting his "Cosmic Smoke Gun," † considers himself equal to any eventuality of space—at least within the cramped confines of the Solar Alliance, where the space patrol maintains space law and space order. Not to obsolesce too quickly, ourself, we've been busier than a one-jetted Venutian, with a plan to collect this moon water in some flying saucers for delivery to the drought-ridden Earth. What if it is impolite to drink from a saucer?

Paul E. Capraro retired as superintendent of the Two Rivers, Wis., Water & Light Dept. last year after 29 years of service to the community. The local utility celebrated its 50th anniversary the same year. He has been succeeded by Donald F. Laubenstein.

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* *Tom Corbett, Space Cadet.* Dell Comic Book Publishing Co., New York (No. 5, Feb.-Apr. 1953).

† 25¢ plus 1 "Rice Chex" box top from the Space Patrol, Box 987, St. Louis, Mo.

(Continued on page 96 P&R)

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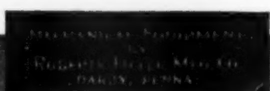

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(Continued from page 94 P&R)

What price water conservation, when one manufacturer can save himself up to $1,300 per month in his water bills? All that coin, of course, has another side, in its effect on water revenues, but in many cities these days, particularly in the drought-bound Southwest, conservation at any cost is a prime necessity.

It is the Boeing Airplane Co. at Wichita, Kan., that has the above-mentioned program in the works, having accomplished savings of $350 per month early in its efforts and pushing ahead with other save-water ways as rapidly as it can. In terms of water savings, its total program will involve 15.3 mil gal monthly, 30 per cent of the 1951 consumption. And all its accomplishments will be achieved by the application of simple devices and techniques already in existence—the installation of thermostatically controlled valves on the cooling system to make water work harder before going to waste, the use of a mechanical water chilling system, the reduction of flush tank size in the toilet facilities for 25,000 workers.

Making water work harder is a view of conservation that ought to be more general by now—certainly there is much more to be saved in efficient use than in merely plugging leaks. And if the water works man is sacrificing some income by the reduction in demand, he is at least gaining some capacity. Besides, very few of us these days have to worry about boosting demand.

Service Lines

"Transmission Systems" for automatic process control, using pneumatic, magnetic, electric, electronic, and electronic-follower means, are described in a 20-page catalog, T-50, distributed by Fischer & Porter Co., 7250 Jacksonville Rd., Hatboro, Pa. The systems are designed for measurement and control of flow, pressure, liquid level, viscosity, and specific gravity.

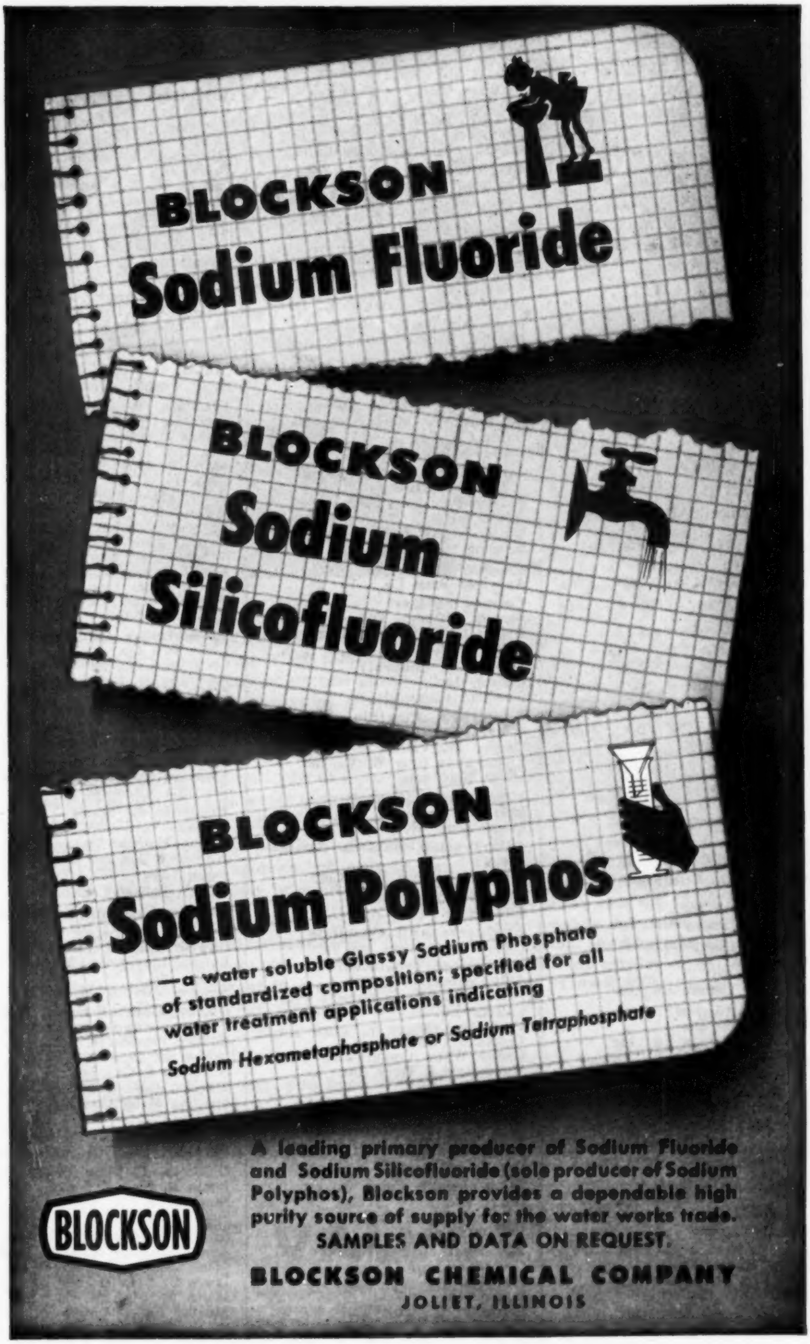
A steel pipe catalog with information on fittings, coatings, installation, dimensions, and other useful data is offered by Southern Pipe & Casing Co., Azusa, Calif. The 42-p., illustrated brochure is entitled "Fusion Welded Steel Pipe" and is available for the asking.

"Conversion Factors for Engineers," a useful little handbook of measurement unit equivalents, may be had for the asking from The Dorr Co., Barry Place, Stamford, Conn. Literally pocket size, the booklet is slanted to meet the needs of the water works man, and is especially strong on units of liquid measure.

A new Flo-Watch meter (Model AFUAQ) for liquids or gas has been produced by Builders-Providence for use with Kennison open nozzles, flumes, or weirs. Adaptable for any combination of totalizing, indicating, or recording functions, the meter can also be equipped with a transmitter attachment to control chemical feeders or other instruments. Essentially the instrument provides the features of others in its line, but at lower cost, for narrow ranges of flow. A 2-page bulletin, 300-J14, may be obtained from the company, 345 Harris Ave., Providence, R.I.

Telemetering applications for control of water and sewage works installations are explained in a special edition of the Autocon *Rambler,* service bulletin of the Automatic Control Co., 1005 University Ave., St. Paul 4, Minn. The automatic transmission of signals to indicate and record various conditions in the system is discussed, together with the associated devices of alarm and control circuits.

Municipal supplies, ranging from "Adjustable stencils" to "Wrenches, hydrant," are fully described and illustrated in a 100-page catalog, No. 148, of W. S. Darley & Co., Chicago 12, Ill. Among water works equipment included are tools and supplies for installing or repairing pipe, pumps, pipe thawing equipment, and pipe and leak locators.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—a water soluble Glassy Sodium Phosphate of standardized composition; specified for all water treatment applications indicating
Sodium Hexametaphosphate or Sodium Tetraphosphate
A leading primary producer of Sodium Fluoride and Sodium Silicofluoride (sole producer of Sodium Polyphos), Blockson provides a dependable high purity source of supply for the water works trade.
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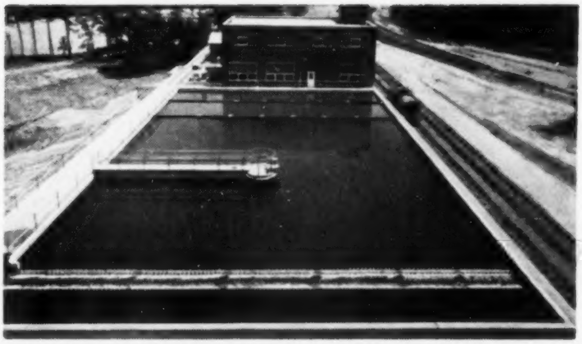
A complete Buyers' Guide to all water works products and services offered by A.W.W.A. Associate Members appears in the 1950 Membership Directory.

Conventional treatment at Hollingsworth & Whitney Company's Chickasaw Mills, Mobile, Alabama. Here, adequate space and a warm climate permitted this Company to take advantage of the low chemical consumption and minimum operating requirements of the Flocculator-Squarex Clarifier combination.



High-rate treatment at Canadian Celanese Ltd. in Drummondville, Quebec. This Hydro-Treator had to be covered because of the Canadian climate, it had to blend in with the surrounding residential community, and space requirements were limited.

Just Like Fingerprints...

some water treatment problems look alike . . . but aren't!

For instance, take the two Dorr installations shown here. Both are industrial water plants — both have approximately the same capacity — and both are installed primarily for color removal. Yet one uses high-rate treatment with a Dorrco Hydro-Treator, the other conventional treatment with a Dorrco Flocculator and Squarex Clarifier.

Why the difference? In this case all-important local conditions. And to prove the equipment specified met these conditions . . . both Companies have recently doubled water plant capacity by exactly duplicating their existing units!

For a complete picture of the many types of Dorr water pretreatment equipment, write for a copy of Bulletin No. 9141. The Dorr Company, Stamford, Conn.

Hydro-Treator, Flocculator and Squarex are trademarks of The Dorr Company, Reg. U.S. Pat. Off.

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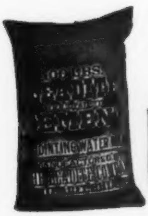
Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%



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